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The Passing Away of His Majesty King George V.

THE Royal Family of Great Britain and the whole Empire have suffered a grievous loss in the death of H. M. King George V, and the grief of the Queen and of the other members of the Royal Household must be inconsolable, but the thought that the whole nation irrespective of colour and creed stands by them in this hour of trial and calamity must assuage and sustain them in their sorrow.

We did not like the look of Reuter's news announcing King George's illness, when the people were warned that cardiac trouble had set in. His illness in 1928 must have worn out all the reserve of strength and any small distemper must naturally produce very grave effects.

His Majesty's rule extending over twenty-five years has witnessed great political vicissitudes, and the world went through unparalleled tribulations. During this momentous period of the world's history, the British Crown alone stood foursquare to all the winds that blew, and this is a remarkable testimony to the personal ascendency which His Majesty's simple life and great personal virtues had established in the hearts of his devoted and loyal subjects. His Majesty's rule was one for which few dynasties in Europe can furnish a parallel. During this eventful period science and letters progressed in a manner which few reigns have witnessed, and His Majesty's tender solicitude for the welfare and prosperity of the Great Commonwealth through scientific progress will be gratefully remembered by posterity. Edward VII was named The Peace-Maker, his illustrious son was a Peace-Lover whose efforts at promoting the peace of the world will form an illuminating chapter of the history of the times.

In the demise of His Majesty, King George V, the world has lost a great monarch, a devout Christian, and an estimable gentleman. We offer our respectful and sympathetic condolences to the bereaved Royal Family.

His Majesty King Edward VIII.

HIS Royal Highness the Prince of Wales has assumed the powers and duties of the King of Great Britain and the Dominions overseas and those of the Emperor of India. For the arduous responsibilities to which he has been suddenly summoned, His Majesty King Edward VIII has passed through a long period of intensive training, guided and inspired by his beloved father. Like the late King George V, the Prince of Wales was a naval officer, a student of the University of Oxford, and has widely travelled. But the greatest experience, which few of the recent British Monarchs possessed, fell to the lot of the new King. During the World War he served both in the Western front and Egypt, and witnessed what horrible troubles, miseries and sufferings a cataclysm of that magnitude implies. It will be remembered that in 1921 His Majesty visited India as Prince of Wales and his charming manners and urbanity won for him universal admiration, and most of all his great popularity amongst the student population was unrivalled.

H. M. King Edward VIII has an intimate knowledge of the labour problems and the demands of the industrial classes, and his recent and frequent tours in industrial areas have provided him with unique opportunities of studying them at first hand, and identifying himself with the poorer people. This is an indispensable equipment for every modern monarch for the success of his rule.

While we tender to His Majesty King Edward VIII our respectful sympathies for the great loss he has sustained, we offer our prayers to the Great Giver of all Good that He may shower His choicest blessings on the New King.

May His Rule be Long, Happy, Peaceful and Prosperous!

Current Science

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CONTENTS.

National Intelligence.

SIR GIRIJA SHANKAR BAJPAI, presiding at the inaugural meeting of the Central Advisory Board of Education held in December 1935, expounded the aims and objects of the Board in these terms :

"The main function of the Board is to impart to Educational thoughts the impulse of progressive policy. It is because we aimed at ensuring fruition of advice into action, that we invited ministers in charge of Education in Provinces to sit on the Board. It is because we aimed at viewing the whole field of Education in one conspectus, that apart from Education Ministers and their Directors of Public Instruction, we have invited the Inter-University Board to send us three representatives. It is because we want our effort to be quickened and influenced by responsible political opinion that we have with us representatives of the Legislature."

Presumably these ambitious sentiments must have formed the concluding portion of an important public pronouncement by the Member-in-charge of Education on the general policy of the Government of India, and it is widely hoped that the large and representative body of eminent Educationists and Legislators who compose the Board might ensure the progressive realisation of the high purpose adumbrated at the inauguration ceremony. It must be remembered that the Central Board is not a statutory body, and is without the power of taking the initiative in the formulation of any educational project or policy. Its function, therefore, is restricted practically to advising the Government of India on problems referred to it, or to inviting information from the Provincial Governments and other organisations interested in educational matters, with a view to examine the material collected in order to frame a co-ordinated scheme of recommendations. Manifestly the success of the Board in either of these spheres must depend on two fundamental factors. The first pre-requisite is the time and energy which the members of the constituent committees can devote to the study and investigation of the special and general problems coming within their purview and having a specific bearing on the development of cognate subjects in the more progressive countries, and how far the members will bring the results of such study and research to bear on the discussion of the questions referred to the Board. The second factor relates to the ability and willingness of the Provincial Governments to adopt the recommendations of the

Board regarding general and technological educational problems. A purely advisory body must before long discover that moral suasion is a feeble instrument with which to recommend the acceptance of its decisions by provincial authorities, and if the resolutions of the Central Board are treated as counsels of perfection, the existence of the Board can hardly be justified. It was pointed out by the Member-in-charge of Education that it is unthinkable to entertain proposals for making education a subject of the Central Government when provincial autonomy is the cardinal feature of Federal Administration. The whole objective of education is to improve national intelligence, and if subjects such as national defence, national communications and foreign relations should require all the tender care and nursing of the Imperial Government, the logic of handing over education, which "quickens and influences" every branch of the Central Administration, to the provincial authorities must puzzle the public.

The policy which controls the destiny of national intelligence must be vested in the Supreme Government, which ought to utilise the knowledge and experience of the widely representative advisory body, in the formulation and application of that policy. For instance, the question which should engage the enquiry of the Central Board as well as of the Government of India is the one which formed the title, "An Intelligent Youth" of the lecture which Dr. S. H. Tucker delivered to the Andersonian Chemical Society at the Royal Technical College, Glasgow, last November. Perhaps an equally important and pressing enquiry for the Central Board is to organize an investigation into the problem of examinations, especially in view of the indictment of the present system made by Sir Philip Hartog and Dr. E. C. Rhodes. At the inaugural meeting of the Central Advisory Board, a series of resolutions were recorded after considering Sir Tej Bahadur Sapru's report on the unemployment problem. It seems to us that all these questions affect the nation as a whole, and apart from the subject of language as the medium of instruction, we fail to detect anything particularly provincial in the educational process at any stage.

Speaking about the employability of university graduates, Dr. Tucker is reported to have remarked that "unfortunately, however, a university degree is not a hall-mark, necessarily, of intelligence. It can be and is acquired by sub-intellectual processes". The results of the investigation into the prevalent system of examination undertaken by the International Institute Examinations Enquiry establish beyond a doubt that the element of chance plays rather a serious part in assessing the capacities of candidates. Even in India employers have begun to realise that the knowledge which a graduate possesses has very little relation to the type of work in which he proposes to engage either in government service or industries. In the United Kingdom, according to Dr. Tucker, employers have so often found that a degree is merely camouflage for ignorance that they have come to associate the two. He thinks that there would be no contempt for university degrees if their possessors could only show ordinary intelligence. Upto a certain point the universities and secondary educational institutions have done remarkably well. They have filled the minds of young men with a large mass of varied facts, and educated people employed in government service and in learned professions have done creditable work. The old doctrine that a university degree or that the tests of a competitive examination fitted the young graduate for any kind of work is still fondly cherished by Governments; but the other employing agents make a distinction between book knowledge and general intelligence. This is precisely the reason why the average student complains that his education does not fit him for any particular employer or any particular employment. No academic training without reference to the aptitudes of the scholars and the actual practical needs of a growing population could assist its recipients in finding profitable employment. To a certain extent the present educational process with its elaborate paraphernalia of examinations, has tended unconsciously to immobilise the young mind; and it seems to us that the whole problem of unemployment centres in the fact that education has not promoted that adaptability of mind to new conditions which the young man should possess on leaving the university.

It is true that large numbers of students come to the universities and technological institutes, convinced that a degree or a diploma is the thing that pays, and there is little incentive to explore and appreciate the intrinsic significance of facts presented in

the class rooms. They possess knowledge, but "intelligence consists in being able to associate these facts and in being able to use them to arrive at new ideas". An unduly large proportion of those who pass through the universities and technical colleges do not possess a sufficiently adaptable mind to rise to that position in the world, which by their high education they should occupy. The volume of unemployment affords evidence for this serious allegation. Unquestionably students are required to study far more than they ought, and certainly more than they actually need in the transaction of the ordinary affairs of public life. The solution of the unemployment problem does not consist in opening technical schools and colleges for those who cannot profit by university education, but it really involves an investigation into the system of training, the hereditary predispositions of young men, the capacity of teachers for giving a lead to the students in the world and the requirements of the employer.

The mind of the average Indian is naturally quick, retentive and sympathetic, and if it is not adventurous or inventive, the fault is due to the system of education which placed before young men, appointments in the services and success in the legal profession as the summit of their ambition. Is the public intelligence trained for leadership and ability to handle public affairs? Does the present system of education render the mind of the rising generation sufficiently elastic and adaptable to the changing conditions and new demands in national life? These are All-India problems, though in certain aspects some of them may have a provincial side. It is almost unthinkable that, even under Federal Administration, the Government of India can afford to relinquish the responsibility of its stewardship of national intelligence in India, the training of which for leadership manifestly depends not only upon the quality and character of the education imparted to the young, but also upon the ability and enthusiasm of the teaching profession. It is a waste of national intelligence to permit thousands of highly educated graduates to drift through life apparently without ambition and without sufficient initiative to make a mark upon the affairs of their world. The obligations of national education extend far beyond the diffusion of knowledge and the promotion of research in the universities, essential as these are for the improvement of public health and of the standard of living. The higher grades of education ought to quicken the genius of the nation, and in the present state of political development, it seems that the task of training and directing the intelligence of the Indian people is the legitimate duty of the Government of India, supported by the Central Advisory Board of Education.

The Diamond Jubilee.

WE have great pleasure in offering our respectful felicitations to His Highness Sir Sayaji Rao, Gaekwar of Baroda, on the occasion of the celebration of the Diamond Jubilee of his long and beneficent rule. As is natural on such occasions, the head of the ruling family received unstinted expressions of loyalty and love from his subjects, and the event was celebrated with exhibitions of popular enthusiasm and devotion.

His Highness was invested with ruling powers in 1881, and has governed the State with conspicuous ability and character. During this long period, the State which is undoubtedly one of the best governed in India, has witnessed reforms, in the inauguration of which Governments of the States, in many respects, move faster than the British Government. For example, Baroda prohibited child marriage long before the British Government could venture to legislate on the subject, made primary education compulsory with provision for adult education, has raised the percentage of educated untouchables to the highest figure in India and has associated the people with the State administration. The policy of the Gaekwar's Government is to build the structure of administration on the village *panchayat* as the foundation, so that steady progress in administration is secured by the representation of the popular element in the Legislature.

The Gaekwar being one of India's elder statesmen, is the doyen of Indian princes,

whose broad outlook is reflected in the enlightened and progressive policy of his State. The knowledge and experience which he has accumulated during his extensive foreign travels must be an asset to the administration and his solicitude for the improvement of village life in Baroda is marked by the recent grant of a crore of rupees for rural uplift. This signal act, coupled with the opening of a new science and technological institute will earn for His Highness the enduring love and gratitude of his loyal subjects, than which nothing can be more gratifying to an Indian Prince. It is the earnest prayer of the people of Baroda as well as of those of the rest of India that His Highness Sir Sayaji Rao may be spared for many years to rule his State and support proposals for a progressive constitution in British India.

Dr. S. S. Bhatnagar, D.Sc., O.B.E. and Sir Bryce C. Burt, Kt.

WE have great pleasure in felicitating Dr. S. S. Bhatnagar and Sir Bryce Burt on the distinctions bestowed upon them.

Dr. Bhatnagar is one of the most popular and distinguished professors of the Punjab University, where, as the Director of the University Chemical Laboratories, his researches have won for him a prominent place in the world of International Science. It will be remembered that in recognition of his valuable investigations of basic importance to the petroleum industry, Messrs. Steel Brothers Company Ltd. and Attock Oil Company recently placed at his disposal large sums of money for further researches on petroleum and allied subjects. In a spirit not unlike that of Faraday, Davy and Pasteur, Dr. Bhatnagar placed the large lump sum grant paid to him by Messrs. Miller and Ward as a personal gift, at the disposal of the University for inaugurating a department of Petroleum Research. Dr. Bhatnagar's latest book on "Physical Principles and Applications of Magneto-Chemistry," recently reviewed in our columns by Dr. Edmond C. Stoner, is a great contribution to the physical and mathematical aspects of the subject, which has won for the author wide appreciation. He has always been a steady and true friend of *Current Science* whose present position is due to his consistent and unstinting support.

Sir Bryce Burt first came into prominence by his distinguished work as Secretary to Central Cotton Committee, and the Government of India, in appreciation of it, appointed him Agricultural Expert to the Imperial Council of Agricultural Research. In this new sphere, he threw the weight of his knowledge and experience in advocating a liberal policy for the promotion of scientific research in all the departments of Agricultural Stations, the Universities and other research centres. On the retirement of Sir T. Vijayaraghavacharya, Sir Bryce Burt became the Vice-President of the Council and this appointment testifies the wide popularity which he enjoys among his colleagues and the esteem and confidence which the Government of India have in his sobriety of judgment and technical knowledge. *Current Science* and *Agricultural Science* owe much to him.

Application of Statistics to Field Technique in Agriculture.

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INTRODUCTION.

APPLICATION of statistics to field technique in agriculture is now assuming an importance and a usefulness which can be compared only to the utility of a tool to a mechanic or of an instrument to a surgeon. Statistics is now an indispensable dissector for an agricultural experimenter to judge the results of his experiments, and the modern agronomist cannot now for a moment dispense with the applications of modern statistical theories for properly designing his experiments and for a valid interpretation of his results. On these aspects of field technique a co-ordinated research is necessary as in every other science, and it seems doubly so in the case of statistics applied to agriculture owing to its varied applications and to the varying conditions under which it is to be applied. The American Society of Agronomy is doing its best to co-ordinate the statistical researches as applied to agriculture, and the Agricultural Research Council in England has been emphasising the need for sound statistical treatments in connection with field experiments. The Imperial Council of Agricultural Research in India is not slow to take to modern statistical ideas, and has been pleading for a correct statistical technique in the case of field experiments in the Provinces and Indian States.

It should, however, be mentioned that statistics is only a means to an end, and that its application to field technique is intended merely to provide standards for comparisons of results from experiments conducted under known conditions. It is in no way intended to create an art by itself and in no way meant to discourage the experimenter from utilising his full knowledge to his best advantage. Even experiments which had not been designed from the point of view of modern statistical ideas could be studied and interpreted, but it should be emphasised that a proper design for an experiment with a view to a valid interpretation of results, would go a great way in strengthening the hands of the experimentalist, and giving him a courage and a conviction in "disentangling the diverse factors that contribute to a joint result". This is just what happens in the study of results of an agricultural experiment, where a number of variations such as soil heterogeneity, varietal effects and manurial effects, operate jointly to produce a single result of, what is known, as the *plot yield*. Under old ideas, a *high* percentage difference in plot yields, say, of two varieties under trial, is a sufficient guarantee that one variety is superior to another, but according to modern ideas while *high* and *low* are purely relative terms, the *significance* of the difference should be based upon a knowledge how far *chance* had operated in bringing out that difference. If the *chance error* is high, even a high difference—say 30 to 40 per cent. difference—may not be *significant*.* This is the experience met with in some of the recent results in agricultural experiments in India, where it was found that a high percentage difference of even 30 per cent. between treatments was found not *significant*. Thus a successful experimenter should try to bring down his random error as low as possible; so that even *small* differences between different factors at work—say differences in yield of different varieties—may on the basis of this error be *significant*. But even more important is the *validity of estimates* of error, which can be secured only by a *suitable design*. The validity of estimate of error depends partly upon whether estimates of other variations such as soil heterogeneity in an agricultural experiment are properly eliminated from our accounts, and partly upon whether our sample of plot yields is a *random* sample of population. A proper design for an experiment is thus the only panacea for ensuring a valid interpretation of results. We have now reached a stage in the progress of field technique, when we could plan even a complex experiment where a number of interrelated factors can be simultaneously studied, and significance deduced.

PRINCIPLES OF MODERN EXPERIMENTAL DESIGN.

This takes us to the *three* broad criteria for a satisfactory experimental design, which are now more or less accepted. *Firstly*, as seen already, the error of the experiment

* The exact connotation of *significance* is explained in the subsequent paras.

should be as low as possible giving a maximum precision for the experiment. This can be secured only by a sufficient number of replications. The need for replications in a field trial is now easily recognised, as the experimenter knows by experience that this is the only way of eliminating from his comparisons the effects of soil variation obtaining in the field. The *second* condition for a satisfactory field lay-out is that the error as estimated should be a *valid* estimate. Old plans of lay-out and methods adopted for estimating the error did not aim at separating the portions of the differences due to several causes, and hence led to aggregates which were of only limited application. For example, Mercer and Hall's method of basing the error of an experiment upon plot variations of individual treatments did not discriminate between the variations due to several factors; so also Engledow and Yule's which did not take into account the soil variation. Modern methods of field experimentation are intended to remedy this defect. The *validity of the estimate* for error can, however, be secured by a sufficient number of replications, provided the plots represent random samples of the experimental area. As this condition is generally not satisfied, what is known as *randomisation* is now introduced in all field experiments [by which plots in each block (or row and column) are randomised with respect to treatments under trial]. This ensures, in the language of Fisher, that "the differences utilised in the estimation of error (by which differences between unlike plots are judged) are properly representative of the other errors which produce the actual errors of the experiment". So long as we recognise that a correct interpretation of results depends upon valid estimates for error, the best way for securing such a valid estimate seems to be only by arranging the plots at *random*. Any systematic arrangement of plots cannot secure an unbiassed estimate for error and the old idea of having unlike plots as close as possible deprives us of a useful method for deriving a valid estimate for error. The arguments against *randomisation* sometimes advanced by agricultural workers are discussed in the next para. The third criterion is that the design should be such that all soil differences could be eliminated from the comparisons to be made and equally well from the estimates of error which form the very basis for judging "significance". It is found from experience that increasing the replications beyond a certain limit cannot bring on an additional precision for the experiment, which, therefore, limits the number of replications. To secure the object of eliminating soil differences, replication cannot therefore be a sole remedy, and the modern plan is to limit the area of the experimental field and to demarcate it into "blocks", or "rows and columns"; thus securing "localisation of control", by which it is possible to eliminate soil differences by proper field arrangement, and to increase the precision of the experiment, without unduly increasing the number of replications.

These three broad criteria for a proper design for a field experiment have led to three broad concepts:—*Replication*, *Randomisation* and *Localisation of Control*. Their objects are, briefly mentioned, to secure a valid estimate of error by means of a suitable design and an improved precision for the experiment by taking into account all possible variations such as soil heterogeneity and varietal effects, and by eliminating them from our calculations of error.

RANDOMISATION—POSSIBLE OBJECTIONS AND HOW THEY ARE MET.

While *randomisation* seems thus theoretically a necessity, there has been an acute controversy among the agricultural experimenters in India and elsewhere with regard to the utility of the method. It would be worthwhile at this stage to examine the objections raised against the method, and see how they could be met. A common objection raised is that the randomised method does not show on the field to the eye of an observer the relative differences between treatments: thus while an arrangement A B C, A B C, in several blocks systematically arranged might show the relative differences of treatments, an arrangement like A B C, A C B, C A B..... could not show at a glance these differences. But this is no argument against *randomisation*, and besides there is a confusion in this argument between a *field experiment* and a *demonstration* plot. While in the latter, the results should be demonstrated to the layman to appeal to his eyes, the former is essentially the domain of an experimentalist—for him to ensure the results and to satisfy, before they can be tried on a large field scale for confirmation. There could be no mistaking these two, and it is wrong to presume that one is a substitute for another.

The second argument usually advanced is that mistakes are easily committed in a randomised arrangement owing to untrained labour, which are avoided in a systematic arrangement. This is again no argument at all and the general experience is that Indian labour, if properly trained even for a short period of one season, picks up the details of even complicated plot arrangements so quickly, that it is unfair to advance this point as an argument against randomisation. The third argument against randomisation is that in several of the systematic arrangements recently adopted in the Indian farms, the standard error is found to be very low—even at 3 per cent.—and that therefore there is no need for changing the plan. But then there is no guarantee that this small error is a *valid estimate* of error, which, as we have seen, is a fundamental condition for a valid interpretation of results. Experience has shown that correlations between plots such as existing between high-yielding and low-yielding plots are often marked, and that they vitiate the results sometimes very badly. Thus any systematic arrangement of treatments in a field experiment seems to have no justification whatsoever. It is therefore seen that while the arguments usually advanced against randomisation are mainly from the point of view of practical agricultural considerations, the theoretical aspects of the problem have not entered into them. *Randomisation* in a field experiment seems therefore a necessity and it seems irrevocable till we can find a substitute for it.

PRINCIPLES OF ANALYSES OF VARIANCE AND CO-VARIANCE.

The whole statistical problem connected with the lay-out of a field experiment thus resolves into the possibility of analysis of total variation of plot-yields into those due to the component factors, and the use to which such an analysis can be put for testing the significance. Such a possibility presupposes a suitable design for the experiment —a design adapted to proper calculations and valid separations of those variations. In a randomised block arrangement, for example, each plot-yield may be regarded as in part due to the particular block in which it is situated, as in part due to the particular treatment and as in part due to a residue on account of what is called *error*.

The method of analysis of total variation into component items is effected by what is now generally known as Fisher's "Analysis of Variance". The method of analysis of variance has become classic in the modern theory of statistics, and it is now freely applied not only to agricultural experiments but to economic and biological studies where a number of factors operate to produce a joint result.

The principle of the analysis of variance as applied to data where only two factors cause variation is brought out by the single algebraic identity :—

$$\sum_{1}^{Kn}(x-\bar{x})^2 = K\Sigma(\bar{x}_p - \bar{x})^2 + \sum_{1}^{Kn}(x - \bar{x}_p)^2.$$

The formula exemplifies the simple truth that if Kn observations be split up into n groups with K individuals in each group, then the total variation or what is known as the 'total sum of squares' can be split up into (1) the 'sum of squares' due to deviations of the *means* of the groups from the general mean (multiplied by the number in each group), and (2) 'sum of squares' due to variations of the individuals from the means of groups to which they belong. These two causes of variation are known as due to 'between classes' and 'within classes'. The two causes of variation are *independent*, and any individual x in the pth group for example may be expressed as $x = \bar{x}_p + \bar{x}$ + error, the error portion being that left over after assuming the effects of the two independent causes. The relative importance of the two variances† measures the correlation, if any, in the sample; if the variances are equal, the correlation is 0, and if they are not we may express the relationship in terms of r. If the variance of 'between classes' is larger than that due to 'within classes', then the intra-class correlation is +ve and if smaller it is −ve. Apart from finding the existence of any correlation or otherwise in the sample the analysis of the total variation into component factors, as we shall see in the subsequent para, provides us with a test of significance for homogeneity or otherwise of the sample, which is by far the most important use to which 'the analysis of variance' has been put.

Equation (1) can now be extended to the case of three items of variation producing a joint result. Thus in the case when Kn individuals are split up into n groups with

† Variance is 'the sum of squares' divided by the appropriate number of degrees of freedom or independent estimates.

K individuals in each group and with the restriction say that the variation of the rth individuals in the several groups is also to be considered, then the identity becomes :—

$$\sum_{1}^{Kn}(x-\bar{x})^2 = K\Sigma(\bar{x}_p-\bar{x})^2 + n\Sigma(\bar{x}_r-\bar{x})^2 + \Sigma(x-\bar{x}_p-\bar{x}_r+\bar{x})^2.$$

This corresponds to the case of a randomised block arrangement with n blocks, and K plots in each block corresponding to K treatments under trial. The last item corresponds to "error" or "interaction" between the first two items of variations. The whole analysis is easily seen to be a process of fitting constants so that the error variance is least ; that is to say, if the observed plot yield y_{uv} (*i.e.*, of uth block and rth treatment) is considered to be the sum of different effects such that $y_{uv} = K + t_u + b_v +$ error then by summing this for all the plots and by applying the method of least squares for minimising the error the best values for the constants will be :—

K = general mean of all plot-yields.
t_u = the treatment mean.
b_v = the block mean.

The principle of "analysis of variance" can now be extended to any number of simultaneous classifications of different sets of groups or classes. Now defining an n-fold classification as one containing n classes or groups into which a sample can be analysed, a randomised block arrangement, say with 4 treatments, is then a *double four-fold classification* (*double*, because only two items of variance *blocks* and *treatments* enter into calculations) ; similarly a 4×4 Latin Square will be *a triple four-fold classification*, and so on. It may be of interest to note that in the types of designs which we are dealing with (*i.e.*, orthogonal‡ designs), as one set of effects does not alter the other sets, the constants may be fitted in *simultaneously* or *one after another*, and the sum of squares for the different effects will be the same by either process. Again so long as the design is *orthogonal*, that is to say, so long as the different items of variance can be estimated separately and directly, the total sum of squares will be equal to the total of the sums of squares contributed by individual items. Thus in a Latin Square arrangement the variances of the different items—rows, columns and treatments—may be separately calculated and their sums of squares totalled up will be equal to the total sum of squares. The calculation of the analysis of variance in cases of orthogonal designs has been simplified very much recently, and the easiest method will be to calculate for each item of variance—say block variance in a randomised block arrangement—the sum of the squares of the totals of several blocks divided by the number of plots in each block and to subtract the correction T^2/n (where T is the total of the plot-yields and n the number of plots) ; and the correction will be the same for all items of variance.

Just as the variation of a single variable x could be separated into several items such as those due to "between classes" and "within classes", similarly if pairs of observation of two correlated variables x and y occur in groups, the co-variation of x and y could be separated into different items. Thus in an agricultural field experiment involving blocks and treatments, the plot-yields in any two years may be correlated, and the co-variance may be analysed into items (1) blocks, (2) treatments and (3) error. The co-variation of x and y is of course measured in terms of *mean product*, just as variation is measured in terms of *mean square* ; b, the regression co-efficient, is the ratio of the co-variance § of x and y to the variance of x. To an agricultural experimenter, the chief interest in the "co-variance" lies in its application to the correction of plot-yields in a set of plots in one year on the basis of yields in the same set in the previous year or years. In a field experiment, a knowledge of preliminary yields may help to know *firstly* how the yields in the experimental year are affected in relation to the preliminary yields and *secondly*—which seems more important—how the standard error of the experiment changes. Assuming a linear regression of y on x, where x is the preliminary yield and y the experimental yield, any correction to be made in the yields of any two plots treated alike in the experimental year, should obviously be based on the difference in yields of those plots during the preliminary period ; and assuming a linear regression $y = bx$, b, the co-efficient of regression is the ratio of "co-variance of error in xy

‡ Explanation of 'orthogonal designs' is given in this and succeeding paras.

§ The *co-variance* is the mean product of x and y measured from their means.

analysis" to the "variance of error" in the analysis of preliminary yields. It is interesting to note that the analysis of variance of x and y, and the analysis of co-variance of x and y follow the same procedure in the matter of computation and that from these tables "b" is easily computated, and hence the sum of squares of the adjusted yields from the formula :—
$(y - bx)^2 = y^2 - 2bxy + b^2x^2$. The adjusted yield itself is then $y - b(x - \bar{x})$.

In experiments on perennial crops (such as 'tea'). a plan of lay-out is now adopted of what is known as 'equalisation of plot-yields,' by which sets of plots in the several blocks are so chosen that the sum total of yields in the same set during the preliminary period is the same. This method of lay-out combined with an assumption of regression between the preliminary and the experimental yields has given excellent results in the reduction of the standard error, and in the effective comparisons between treatments. But in the case of a few experiments on perennial crops conducted in India the co-variance between preliminary and experimental yields has not given any increased precision for the experiment. It should, however, be pointed out that where treatments themselves have produced differential effects during the preliminary period, the method of co-variance (or the assumption of regression of *error* between the plot-yields during the preliminary and the experimental periods) fails to give a correct perspective for an altered *precision* for the experiment. This is a very important point to be borne in mind in the application of the method for judging the improved precision of experiments on the basis of preliminary trials. But where the preliminary trial is an unbiassed uniformity trial (*i.e.*, subject to the same or no treatment), then the method can be freely applied.

Other Applications of the Method of Co-variance.

It is possible to apply the method of co-variance to other cases arising in agricultural experiments, where accidental factors come into play such as uneven germination and insect pest, the effects of which cannot be measured. In such cases, we might, for example, correlate the number of plants with the eventual yields, and thus correct for the differences in the plant number in different plots by the method of co-variance. The germination count in different plots will thus be a very important guide in judging the effects of such accidental factors. Another use to which the method of co-variance can be usefully employed in an agricultural experiment is to know what exactly the factor or factors connected with the crop that influence the eventual yields. This will be of great help to understand the different stages of plant growth leading to the yield as the effect of treatments. Thus in the case of cotton, if boll-count should be the deciding factor, we might assume a regression of the yield on boll-count; or if the yield should depend upon the boll-size that will be the factor to be correlated. As another example, in the case of rice or wheat, we know 'tillering' is a very important factor influencing the yield, and we might usefully study by the method of co-variance its effects, at several stages of plant growth, on the yield. Thus the method of 'co-variance' helps to study 'the mechanism' by which the treatments produce their eventual effects. Such intensive studies have been undertaken in some of the Indian farms but the results need to be collated in a broader perspective.

Choice of Proper Statistics.

Once that the variations can be analysed into their component factors on certain valid assumptions, the problem turns out to be one of the study of '*significance*'. Stripped of all technical language the question is :—"If with respect to a *sample* the variance of one is larger than that due to another, can we say that the variation of the first is *significantly* higher than that of the second?" In an agricultural experiment to judge, say, the comparative performances of varieties, what is needed is firstly whether the variance due to varieties is *significantly* larger than that due to error, so that we can say with confidence that our experiment is a success; and secondly whether on the basis of 'error' one variety is *significantly* superior to another. Both these tests depend upon the exact meaning and implication we attach to the expression 'significance'.

The connotation of what is termed as 'significance' or 'significant difference' obviously depends upon what we can expect in the *population* of which our data are a sample. From the *statistic* or *statistics* calculated from our *sample*, can we say that it is a random sample of the original

population? In other words, a sample of size n is observed, and the problem is whether we could say that the sample is a random sample of the original population. In case the character of the population is known, inferences with regard to the sample are expressed in terms of mathematical probability, but where we should infer from the sample only, the problem is firstly one of estimation of the population and then the probability of occurrence of the sample, which, in the language of Fisher, is a function of the unknown parameters of the population which we are trying to evaluate. Fisher would call this function *likelihood*, and his solution by "the method of maximum likelihood" (explained later) would provide *efficient statistics*. In an agricultural experiment n cannot be large and this adds to the complexity of the problem. The main difficulty, however, is to specify the population in terms of the sample. If the character of the population *can* be assumed,—such an assumption is not always valid,—then it is easier for us to verify by mathematical processes whether the sample is a random sample. The *specification* of the population is by means of parameters based upon *statistic* or *statistics* which are functions of the variables. Thus we may specify a population by $y = a + bx + cx^2$ and so on, where a, b, c..... depend upon the statistics to be calculated from the observations. The choice of the mathematical expression itself is largely intuitive, and χ^2 test (explained later) will show how far the assumption is justified.

In the problem of estimation, however, we shall have to assume the form of the curve for the population with one or more unknown parameters. Now then with the *sample* values, the first requirement is the choice of the statistics for an estimation of the parametric functions of the population, and the second is to calculate the *chance* for the sample *being a random sample* of the population. While the first requirement involves a suitable choice of the statistic or statistics,—for any number of such statistics will be available for estimating the unknown parameters of the population,—the second requirement is answered by a study of the mathematical law of distribution of the statistic or the parameter evolved out of it, as it varies from sample to sample of a constant size. n, the size of the sample, thus becomes a primary consideration both in the choice of the statistic or statistics and in the evaluation of distributions. Fisher classifies all *statistics* into those *consistent and inconsistent, efficient and inefficient* and *sufficient and insufficient*. In estimating parameters of the population, we could have innumerable statistics from which to estimate them, but the conditions for a proper statistic are:– *firstly*, that it should tend to a fixed value as the size of the sample is continuously increased, or in other words, that it should centre round a fixed *value* with errors or deviations from it distributed in a normal curve; *secondly*, the particular statistic selected should give a very low variance in *large* samples, *i.e.*, lower than those of other statistics which we could possibly think of, and *thirdly*, the statistic selected should be examined for its sufficiency, that is, whether it can supply all information regarding the sample, in which case, even if it does not give a low variance, there is no need for the calculation of other statistics. The first criterion secures *consistency*, the second *efficiency* and the third *sufficiency*. Taking the Arithmetic mean of a sample as an example of the statistic from which to calculate the parameters of the population, we know that it is *consistent*, since in large samples it is distributed in a normal law. But its *efficiency* will depend upon whether other statistics are *not* available also normally distributed as n is increased, but giving a *lower variance* for the purpose of estimating the parameter of the population. Now since the variance falls off inversely with n, the condition for efficiency is that the limiting value of $\frac{1}{nV} \leqslant i$, where i is independent of the estimation used. Thus if the original curve be *normal*, the Arithmetic *mean* is consistent and efficient in estimating a parameter of the curve, but its efficiency is lowered when it is used to estimate say an exponential curve, where other statistics define the parameter of the curve more accurately. Again in *small* samples, the *Arithmetic mean* is sufficient to give complete information of the sample, and though it may *not* be efficient in the sense explained above, it serves the purpose so far as it completely summarises all possible and available information from the sample.

Thus we shall have to choose from a number of *consistent efficient* statistics the most suitable one to deduce the best estimates of the parameters of the population. Fisher's method of maximum likelihood helps

solution of the problem. If θ be the unknown parameter of the population, the method consists in multiplying the logarithm of the expected frequency in each class by the observed number, and summing for all the classes; and solving for θ such that the sum is a maximum. As a simple example, if a, b be observed numbers in two classes so that $a + b = n$, with probabilities of their occurrences say $f(\theta)$ and $1-f(\theta)$ respectively, then the maximum likelihood solution will give θ for which

$a \log f(\theta) + b \log \{1-f(\theta)\}$ is a maximum. The positive solution for θ secures a statistic with a low variance.

χ^2, t, z TESTS OF SIGNIFICANCE.

From what has been said, what is needed with respect to a sample of n observations (n not being large) is the deduction of valid tests of *significance*, to know *firstly* whether the sample is a random sample of a homogeneous population, and *secondly* whether the *means* calculated from the sub-samples differ significantly on the basis of analysis of variance. Dealing with 'variance', it is probably legitimate to assume that the original population is *normal*, in which case the scheme of analysis of variance explained already, combined with a knowledge of distributions of the statistic or statistics in random samples helps to arrive at proper tests of significance. In the case of an agricultural experiment, the procedure of analysis into variances due to blocks, treatments and error (or in the case of complex experiments including all interactions of higher orders) helps an understanding of how best the test could be applied.

There are three such tests now in vogue which are easily explained. What is known as χ^2* test (or test of 'goodness of fit') given by Karl Pearson in 1900 is intended to test agreement *between observation* and *hypothesis* where the variates are normally distributed and mutually correlated. It is based upon the distribution:

$$df = \mathrm{K}\ \chi^{n-1} e^{-\frac{1}{2}\chi^2} d\chi.$$

'Student' showed in 1908 that the same law holds good in the case of the mean square of a random sample drawn from a normal population. χ^2 test has however been found not effective when either the method of fitting is inefficient, or when negligible values are included in the cells of the sample. But generally speaking, the method has been found to be one of the most powerful tools in modern statistics, which ensures the very first step in all biological studies for verifying observation with any assumed hypothesis. But there is some misunderstanding with regard to the full utility of χ^2 test which seems to have arisen from the confusion sometimes caused in the two independent statements:—

(1) A sample does not differ *significantly* from an assumed population $f(x)$.

(2) A sample is most *likely* to be a *sample* of a population $f(x)$.

While (1) can be tested by χ^2 method, it does *not* however follow from (1) that (2) is true. There might be any number of populations of which the given sample could have been extracted, all satisfying the χ^2 test at the same or particular levels of significance, but only those giving low variances are to be preferred. In other words, χ^2 method is useful only to this extent, that it can safely be employed to test whether the given observations agree with an assumed law or not, but not to test the reverse that the original population should be the one assumed. Thus, for example, it can be employed to test, in genetics, whether there is agreement between observations and Mendelian class frequencies, or in biology *independence* in a four-fold or an n-fold classification assuming the marginal totals to be true. But in either case, unless fresh evidence is adduced, the complete identity of the sample cannot be assured.

't' and 'z' Tests.—The two other tests 't' and 'z' have now become very popular with the agricultural experimenter. In fact, no experimenter now-a-days takes the trouble of enquiring whether conditions necessary for the applications of these tests are fully satisfied; but it is however found that even when those conditions are *not* completely satisfied, they can safely be employed for testing 'significance'. What is known as 't' test is to test whether the observed 't' from a sample, *i.e.*, $\left(\frac{\text{mean}}{\text{S. E. of mean}}\right)$ follows the distribution of 't' from all possible random samples of size n (for varying values of n). 'Student' gave his distribution of 't' in 1908, in his classical paper 'the probable error of the mean'. The utility of Student's distribution is now seen in almost every kind of problem where the significance of any statistic in terms of its standard error

* $\chi^2 = \Sigma x^2/m$ where $m+x$ is the number observed, and m the expected.

has to be tested. 't' tables have been constructed (*e.g.*, Fisher's tables) based upon theoretical distributions, giving the *probability* or *odds* for or against deviations from the observed 't' occurring due to chance from which the significance could be judged. The theoretical distribution of 't', as in the case of those of other statistics, is based on the assumption that the original population is normally distributed, and that a random sample of size n is drawn from it so that the chance of $(x_1, x_2 .., x_n)$ in the interval $(dx_1, dx_2 .., dx_n)$ is given by :—

$$df = \mathrm{K}e^{-\frac{1}{2}\sum_1^n \left(\frac{x_r - x_m}{\sigma}\right)^2} dx_1, dx_2 .., dx_n$$

(where m and σ relate to the population). By a suitable transformation, the distribution of s^2 {*i.e.*, that of 'the variance' of the sample calculated from the expression $\frac{1}{n-1}\Sigma\left(x_\gamma - \bar{x}\right)^2$ is deduced, and similarly that of 't'. We have after transformation :—

$$df = K' e^{\frac{-n(\bar{x}-m)^2}{2\sigma^2}} e^{\frac{-(n-1)s^2}{2\sigma^2}} s^{n-2}\, d\bar{x} ds$$

showing that x and s are independent, so that the distribution of s is :—

$$df = K' \left(\frac{S}{\sigma}\right)^{n-2} e^{-(n-1)s^2/2\sigma^2} \frac{ds}{\sigma}$$

It can be shown that the mean value of s^2 from all possible samples is σ^2 showing that s is an unbiassed estimate for σ and that by the method of maximum-likelihood the best estimate for σ is s (*i.e.*, giving the smallest sampling variance). But be it noted that s^2 is calculated with $(n-1)$ as divisor in place of n to give an unbiassed estimate for σ^2, which is necessary for the simple reason that we are estimating both the mean and the standard error from the same sample, both deviating from their true values.

What is known as Fisher's 'Z' test is more comprehensive (t test, as we shall see, is only a special case of 'Z' test) and is intended to test whether the given sample is a random sample of a normal population. Fisher's 'Analysis of Variance' combined with the 'Z' test are now a landmark in the theory and practice of statistics applied to agricultural field technique. The principle of 'Z' test is this :—When the total sum of squares is split up into different sums due to a number of items, the variance of each item (*i.e.*, the sum of squares divided by the appropriate degrees of freedom) should be an *unbiassed* estimate of σ^2 of the population. If s_1 and s_2 are two such estimates of samples of a normal population derived respectively from n_1 and n_2 degrees of freedom, the distribution of

$$Z(= \tfrac{1}{2}\log_e s_1/s_2)$$

for varying values of n_1 and n_2 is an efficient statistic, and should help in judging whether our sample is a random sample of a normal population. What are known as 'Z' tables, at 5%* and 1%* levels have been constructed by Fisher on the basis of the distribution of Z, for varying n_1 and n_2. The distribution of 'Z' is based upon the distribution of s_1 and s_2, and is given by :—

$$df = \frac{2n_1^{\frac{n_1}{2}} n_2^{\frac{n_2}{2}} \mathrm{T}\left(\frac{n_1+n_2}{2}\right)}{\mathrm{T}\left(\frac{n_1}{2}\right)\mathrm{T}\left(\frac{n_2}{2}\right)} \times \frac{e^{n_1 z} dz}{(n_1 e^{2z} + n_2)^{\frac{n_1+n_2}{2}}}$$

s_1 and s_2 should not appreciably differ if they relate to a random sample of a homogeneous normal population, but if they do, it will be indicated by a low value of P, and the sample cannot then be a random one. It may be pointed out that the 't' test is only a special case of 'Z' test, since for $n_1 = 1$ and $n_2 = n$, $Z = \frac{1}{2}\log_e t^2 = \log_e t$. Thus if we take any value of 't' from 't' table for n, $\log_e t$ will be the same as 'Z' from 'Z' table for $n_1 = 1$, and $n_2 = n$.

In an agricultural experiment where the total variance is split up into variances, say, due to blocks, treatments, and error, denoted respectively by s_1, s_2 and s_3, then if $\frac{1}{2}\log_e s_2/s_3$ is greater than 'Z' from the tables, at any level significance, (5% or 1% level is by convention the usual level taken), we infer that the soil is heterogeneous; if $\frac{1}{2}\log_e s_2/s_3$ is similarly greater than the theoretical 'Z', the general effect of treatments is significant. In either case, however, the sample cannot be a random sample from a homogeneous normal population. The success or failure of an experiment will depend upon the later criterion, *i.e.*, whether the variance due to treatments is significantly greater than that due to 'error'; if it is not greater, then the 'error' preponderates and no inference is possible from the experiment. From the 'Z' test we

* 5 per cent. level=chance 1 in 20 ; 1 per cent. level= chance 1 in 100.

proceed to compare the treatment-means by '*t*' test on the basis of the residual error. If s be the standard deviation per plot and n the number of replications, $s/\sqrt{n}$ is the standard error of treatment-mean and $\sqrt{2}s/\sqrt{n}$ is the standard error of difference of two means; this multiplied by '*t*' from the tables (at 5% or 1% level of significance) will be the critical difference between the means; if the difference between any two treatment-means exceeds this critical difference the difference between treatments is taken to be *significant*.

Doubts have been raised off and on, both by statisticians and agronomists, firstly about the validity of '*Z*' test on the score that the original distribution may or may not be normal for which in any case there is no evidence; and secondly, whether, after establishing that the sample is *not* a random sample from a homogeneous normal population by the '*Z*' test, we are justified in accepting the estimates of variances as *valid* estimates. The first objection is equally applicable to distributions of other statistics also, such as s and t, and our justification is that an assumption of a homogeneous normal distribution for the original population is sufficiently valid for all practical purposes, and that any departure from normality does not sufficiently impress upon our final form. With regard to the second point, it can be easily proved that the validity of the estimate for 'error' is *not* affected by any change in our hypothesis and that only the variances due to other factors are affected. But though this may be true, the adequacy of '*Z*' and '*t*' tests is still there, and it is not in any way vitiated by the change in variances under 'blocks' or 'treatments.' It should be remembered that our analysis of variance procedure is not intended so much to *estimate* the variances, as to provide *adequate tests of significance*.

EXPERIMENTAL DESIGNS—MISSING PLOT TECHNIQUE.

Enough has been said to show that for a valid interpretation of results in a field trial a suitable design (combined with a proper method of analysis of the results) is absolutely and fundamentally necessary. Such designs may be classified into *orthogonal* and *non-orthogonal*. Examples of orthogonal types are the usual randomised block method and the Latin Square arrangement of plots where it is possible to estimate *separately* and *directly* the different items of variance; in such cases, the *mean* yield of all the plots receiving the same treatment, or the *mean* yield of block totals provides the best estimate for the treatment or block effects. It is thus possible in a randomised block arrangement to estimate from the treatment means the treatment effects, from the block means the block effects and so on, without either of them affecting the rest in the eventual calculations. In any such design, increase in fertility in one block affects all treatments *alike*, and conversely the effect of a particular treatment influences the yields of all the blocks; blocks and treatments are thus mutually orthogonal. Fisher's procedure of Analysis of Variance is particularly adapted to orthogonal types of experiments, though the procedure of analysis of variance in all cases is only an application of fitting constants which is the general method of analysis in dealing with all designs including even non-orthogonal types. Cases of non-orthogonal types are however unavoidable even in experiments of what are known as *simple* types, *i.e.*, with only one set of factors under trial—say a few varieties to be tested. It is, for example, quite an ordinary occurrence to see a few experimental plots spoiled by accident such as insect pest and flood so that the intrinsic yields of these plots are not known, or again for lack of knowledge of the initial fertility of the plots to get differences in treatment yields very much pronounced. In a recent case of an experiment which came to the notice of the author, not only was the design faulty as both the plot size and block size were abnormal with an insufficient number of replications, but also some plots were found to give abnormal yields. The orthogonality of the design in such cases is so much disturbed, that either the whole experiment should be discarded, or mathematical devices employed to correct for the abnormalities. In such cases the usual method of analysis of variance should be modified to suit each particular case.

In case where only one or two plots are 'missing', the usual procedure of the Analysis of Variance easily helps to calculate the best values for the missing plots. Thus if x, y be the 'missing' values, we have only to calculate algebraically, 'the error variance' by the usual method of analysis (which will involve x and y), and to minimise the variance by differentiating it with respect to x and y, by equating the two differentiated

functions to zero, and by solving the equations for x and y to obtain the missing values. The process is the same as fitting constants to give a minimum variance to 'error'. The principle may be extended to the case of any number of missing plots, but it is *not* advisable to carry the process to more than 2 or 3 missing plots. There are, however, two points to be noted in such an analysis :—Firstly, the number of degrees of freedom for 'error' will be the usual number less the number of 'missing' plots, for the simple reason that values of constants have been derived from the known plots only. Secondly, 'the treatment variance' obtained after substituting the missing values is bound to be less—though only slightly ordinarily—than usual, and thus the application of any missing plot formula will show an exaggerated accuracy for the treatment averages. In such cases, a correction has to be applied which will depend upon the analysis of the original values, with 'the error' portion deduced from the calculated values.

COMPLEX EXPERIMENTS—CONFOUNDING.

It is the glory of the recent developments of statistics, that modern field technique aims at testing any number of inter-related factors simultaneously. Thus in the same experiment of a cultivation trial, sowing date, spacing of plants and age of seedling may all be tried together, instead of having three separate experiments with one for each of the factors. This would not only economise time, space, and energy, but would also aim at the truth more accurately than what an experiment with only a single factor could do. In fact, where a number of deliberate factors influence a result, such as sowing, spacing and age of seedling would with respect to the yield, it seems futile to try each of the factors separately. The only satisfactory method is a complex lay-out involving all the factors with a suitable planning. Such complex experiments may always be *orthogonal*, that is, if for example 3 sowing dates, 4 spacings and 3 ages of seedling should be tested, $3 \times 4 \times 3 = 36$ treatments may all be completely *randomised* in the same block, with say 4 or 5 replications. This is an ideal method for such trials, and is analogous to a simple experiment which we have dealt with already, except for a change in the items to be considered in the eventual analysis of variance ; in such cases not only should we consider the main effects but also the interactions between the several factors which may in some cases be appreciable. Thus, in the particular example which we are considering, the different items of variance will be (1) sowing dates, (2) spacings, (3) ages, (4) to (6) interaction between sowing and spacing, that between spacing and age and so on, (7) second order interaction between all these factors, and (8) error. The method of calculation of the several variances is the usual procedure and for arithmetical calculations for working out the interactions, say that due to sowing and spacing involving 12 ultimate treatments, the variance of these 12 treatments *minus* that due to sowing *minus* that due to spacing will give the interaction required. This procedure is, as noted already, the same as fitting constants to represent the several effects and deducing them by the method of least squares.

But difficulties in the conduct of orthogonal complex experiments are experienced to be :—(1) the agricultural difficulties in the arrangement of diverse factors in a single lay-out; for example, where differential irrigation is involved, it brings on lateral seepage from plot to plot ; (2) the huge extent of land needed for the experiment, which the experimenter usually finds difficult to secure. In either case, the remedy is found to be to 'confound' the effects by a deliberate plan, and to alter suitably the usual methods of analysis; such a process of 'confounding' will not only economise labour and space but will provide, as Fisher has shown, very efficient tests of significance.

We will consider here two simple methods of 'confounding' which may be usefully adopted by the agricultural experimenter in India. Take the case of an experiment involving two treatments, represented by types A and B, with n_1 and n_2 numbers respectively in each class, so that there are $n_1 \times n_2$ ultimate treatments. A type of lay-out which meets the first difficulty is to have n_1 sub-blocks in each block, and to have n_2 plots in each sub-block ; the n_1, A-treatments, and n_2 B-treatments corresponding to each of n_1 A-treatments, being separately randomised. This is a case of 'confounding' the main effects with a *partial* randomisation only, and the Analysis of Variance should separate the error of the A-treatments from that of B-treatments as shown below ;—

A–TREATMENTS.

	Degrees of Freedom
Blocks	.. (K − 1)
A–treatments	.. $n_1 - 1$
Error (A)	.. Kn_1-K-n_{1+1}
Total :—	$Kn_1 - 1$

B–TREATMENTS.

	Degrees of Freedom
From Blocks and A–treatments	.. $Kn_1 - 1$
From B–treatments	.. $n_2 - 1$
Interaction between A & B	$(n_1-1)(n_2-1)$
Error (B)	.. $(K-1)(n_1n_2-n_1)$
Grand Total :—	Kn_1n_2-1

The defect in this method of lay-out however is that the two errors A and B cannot be consistent in the sense, that while A-error is derived from fairly big plots, B-error is deduced from contiguously small-sized plots which would therefore be small. The efficiency of the experiment is thus disturbed, but for all practical purposes the lay-out may be considered satisfactory so long as block size is not unduly large.

(2) A second method of confounding which may be usefully adopted meets the second difficulty. Instead of having all the ultimate treatments in the same block, a complete replication may be sacrificed in such a way that each block may be divided into sub-blocks and sub-block differences may be confounded with higher-order interactions (such as sowing date × spacing × seedling age), and eventually allowing for the confounding in the analysis of variance. This is on the assumption that higher order interactions are small as compared to the experimental errors, and that instead of *adequate replication* which provides the basis for *error*, these interactions may be substituted. Thus a block containing the treatments *n*, *p*, *k*, *np*, *nk*, *pk*, *npk* and *c* (control) may be split up into

n	*k*
p	*npk*
nk	*np*
pk	*c*

so that second-order interactions are confounded with sub-block differences. In the case of those items which are not confounded, *i.e.* which are orthogonal to one another, the usual procedure of computing the sum of squares will be followed but in the case of those confounded, the general method is *fitting constants* to represent those items and calculating the sum of squares due to fitting. But where the design permits to take account of block differences which confound the interactions, it is easier to compensate for such differences, eventually leaving the confounded degrees of freedom orthogonal with the blocks and also with all the other treatments. Designs of particular types alone will answer these conditions and here it is, where confounding is resorted to, a clear idea of the plan and the procedure of analysis is necessary; otherwise the experimenter will be landing himself in extreme difficulties in the matter of analysis.

In India for field experiments non-orthogonal designs are slowly coming in, in different forms, and research is necessary to explore the full possibilities of such designs with correct methods of analysis. Here indeed the Statistician has his part to play, as indeed on so many other matters connected with the field plot technique.

EXPERIMENTS ON PLOT-TECHNIQUE IN INDIA.

From the Indian experimental data available so far, it is apparent that there has been a lack of uniformity in the conduct of field experiments in the several Provinces and States. Not only are the field experiments sometimes not properly planned, but also they are not carried through for a sufficient number of years to allow for a reasonable weather sampling. The various factors governing the error of an experiment—such as the plan of the experiment (*e.g.*, whether it should be of randomised block type, or a particular Latin Square type), or what should be the suitable *plot size* and *block size* and the *border effect*—should be fully examined under Indian conditions. Experiments to decide these factors are in progress in some of the farms, but the results have not been collated to be of much guidance. The usefulness of complex experiments should be fully explored; so also of confounded experiments which will not only economise labour and time but will provide very efficient tests of significance. "Sampling technique" *i.e.* methods of taking samples from experimental plots such as for physiological study, have not been studied yet with different crops. Again, in the case of *manurial* experiments particularly, we should know the residual and accumulated effects of manures for which special planning for experiments is necessary. What are known as "Permanent Manurial Experiments" should be

suitably planned if the results should be of any value.

Enough has been said to show that India should evolve her own methods both in the matter of planning, and in the conduct of agricultural field experiments. A co-ordinating agency is of course necessary, and there is ample scope for mutual fellowship between the statistician and the agricultural experimenter.

The Antianæmic Principle of Liver.

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THE use of liver in the treatment of pernicious anæmia constitutes a striking therapeutic advance of great importance. The idea must have first originated from Whipple and Robschiet Robbins[1] who in their search for blood regenerative foodstuffs found that of all the substances they investigated, liver was most potent as a hæmopoietic material. This discovery led Minot and Murphy[2] in 1926 to make a clinical trial on pernicious anæmia patients and as a result of their classical researches they obtained a remarkable improvement in the blood picture of the treated patients. Since then, there have been a number of investigations supporting their regimen and now we can completely restore the anæmic patients to normal health by administration of liver.

Etiology of Pernicious Anæmia.

Although the results of Minot and Murphy made it a logical conclusion that pernicious anæmia is a disease due to a dietary deficiency, there were also other theories prevalent to explain its cause. The accumulation of toxins in the body, the infectious disorders in the intestinal flora and the absence of the anti-hæmolytic substance were individually suggested as the causative factors. The exact etiological significance of the defective gastric secretion was first suggested by Fenwick[3] in 1880 and has, since then, been supported by other investigators. Goldhammer[4] has shown that gastric secretion is proportional to the red blood cells and in pernicious anæmia there is a sub-normal amount of gastric secretion also characterised by complete anacidity. Castle and his coworkers[5,6] have shown conclusively that the stomach of a normal human being secretes some enzymic principle which, when allowed to react *in vivo* or *in vitro* with some substance present in the animal proteins of the food, produces the necessary antianæmic factor. The non-occurrence of this reaction in the body is believed to be a defect in the gastric digestion leading to pernicious anæmia. The secretory product is called the intrinsic factor and the substance derived from the food the extrinsic factor. The specific antianæmic principle thus produced is stored in liver from which it is elaborated as required by the bone marrow to produce the normal quota of erythrocytes.

The site and the mode of interaction of these two factors are not known. Their chemical nature is also obscure. The intrinsic factor is believed to be unrelated to either hydrochloric acid, pepsin, rennin or lipase. Klein and Wilkinson[7] have studied this intrinsic factor in considerable detail and have named it enzyme "hæmopoietin". Like most of the enzymes it is destroyed by heat. Griffith[8] has observed that its action is confined to P_H 3·5–5·5. The food factor is, on the other hand, thermostable and is found to be present in beef-muscle, autolysed yeast, rice polishings, eggs and liver. It is not identifiable with any portion of vitamin B complex.[9,10]

Following the earlier papers of Castle and his coworkers. Sergius and Isaac,[11] and Wil-

[1] Whipple, G. H., and Robschiet Robbins, F. S., *Amer. J. Physiol.*, 1925, **72**, 395.

[2] Minot, G. R., and Murphy, W. P., *J. Amer. Med. Assoc.*, 1926, **87**, 470; 1927, **89**, 759.

[3] Fenwick, S., "On Atrophy of the stomach and on the nervous affections of the digestive organs." J. & A. Churchhill, London, 1880.

[4] Goldhammer, S. M., *Proc. Soc. Expt. Biol. Med*, 1935, **32**, 476.

[5] Castle, W. B., and his coworkers, *Am. J. Med. Sci.*, 1920, **178**, 748-764.

[6] Castle, W. B., and his coworkers, *Am. J. Med Sci.*, 1930, **180**, 305; 1931, **182**, 741.

[7] Klein, L., and Wilkinson, J. F., *Biochem. J.*, 1934, **29**, 1684.

[8] Griffith, W. J., *Biochem. J*, 1934, **28**, 671.

[9] Diehl, F., and Kuhnau, J., *Deutsch. Arch f. Klin. Med.*, 1933, **176**, 149.

[10] Lassen, H. C. A., and Lassen, H. K., *Am. J. Med. Sci.*, 1934, **188**, 461.

[11] Sturgis, C. C., and Isaac, R., *J. Am. Med. Assoc.*, 1929, **93**, 747.

kinson[12] showed that in some cases stomach preparations were as effective in bringing about the remission of the disease as liver itself. Snapper and Preez[13] have recorded instances where patients refractory to liver treatment responded very well to stomach preparations. This should not be taken to mean that stomach preparations will generally replace the liver therapy. In the instances cited it is likely that the gastric secretion has reacted on the proteins of the gastric tissues themselves to produce the required anti-anæmic principle.

Another collateral evidence for the inter-relationship of stomach and liver in the etiology of pernicious anæmia is furnished by the work of Goodman[14] and others who have shown that after gastrectomy in the pig, the antianæmic potency of the liver becomes progressively depleted and the animal becomes anæmic. But the total extirpation of stomach in man may not necessarily be followed by the development of pernicious anæmia even after some years. Evidence has recently been adduced by Meulengracht[15] that the active principle of the hog's stomach is present largely in the pyloric region where glands of a type closely resembling those of duodenum of both man and the hog are found. Further, the kidney also is known to contain some of the antianæmic principle and this circumstance might delay the onset of anæmia. This latter fact also renders difficult the postulation that disease of the liver may specifically produce an interruption in the metabolism which leads to the production of the active principle. Further work is needed to elucidate these interesting points.

TREATMENT.

For the oral administration, the patients require about half a pound of whole liver or its extract per day and the patient often takes an aversion to injest such large quantities, particularly when the malady is complicated by nausea, vomitting, sepsis, and such other complications. Moreover, oral administration of the liver preparations to patients suffering from a severe type of pernicious anæmia may not prove sufficiently rapid and the presence of strong auto-agglutinants in the patient's blood may render blood transfusion unsatisfactory. More recently, therefore, the extract has been purified free from proteins and such other impurities and rendered suitable for parenteral injections.[16,17] The effectiveness of the parenterally administered material is about 30-40 times as great as when given by oral route. The maximum increase in reticulocyte is also reached sooner than in the case of oral administration.

PREPARATION.

The full liver action of any preparation of liver extract can be secured only by the employment of unexceptional raw material, careful and skilled treatment of this material and a high degree of concentration of the active substances. Three methods are generally in vogue for the preparation of the active liver extract. The first is that employed by Cohn and his coworkers.[18] The raw minced liver is adjusted to a P_H 5·2, extracted with water and the heat coagulable proteins separated by heating the extract to 70°C. It is then concentrated under vacuum, extracted with ether and finally precipitated by alcohol. The other method, described by Castle and Bowrie,[19] is to extract the well-minced liver with ice-cold water for 12–18 hours, remove the heat coagulable proteins and then concentrate the extract. The third method is described in *British Pharmacopœia* and consists in extracting the liver straightaway with 80% alcohol and concentrating the alcoholic extract. All these preparations are suitable for oral administration and for purposes of injection they are further purified by suitable methods.

The fluctuations in the clinical reports of the several preparations thus obtained emphasise the need for a complete study of the conditions for obtaining a highly potent extract.

NATURE OF THE ACTIVE PRINCIPLE.

Although much has been already learned about the therapeutic constituent of liver, its precise nature is still obscure. In the beginning, since iron and copper were known to accumulate in liver, the therapeutic value was

[12] Wilkinson, J. F., *Proc. Roy. Soc. Med.*, 1933, **26**, 1341.

[13] Snapper, I., and DuPreez J. D. J., *Nederland Tijdschr. Geneeskunde*. 1931, **75**, 29.

[14] Louis Goodman and others, *Proc. Soc. Expt. Biol. Med.*, 1935, **32**, 810.

[15] Meulengracht, E., *Proc. Roy. Soc. Med.*, 1935, **28**, 841.

[16] Wilkinson, J. F., *Lancet*, 1931, **221**, 791.

[17] Gansslen M., *Klin. Wochschr.*, 1930, **7**, 2099.

[18] Cohn Minot, Alles and Salter, *J. Biol. Chem.*, 1928, **77**, 325.

[19] Castle, and Bowrie, *J. Am. Med. Assoc.*, 1929, **92**, 1830.

ascribed to these inorganic constituents. But very recently it has been definitely shown[20,21] that neither liver ash nor extraneous Iron or Copper produces in pernicious anæmia cases the well-known beneficial effect obtained with liver.

During their fractionation studies, Cohn and his coworkers[18] located the active principle in the filtrate from basic lead acetate. It could be precipitated by phosphotungstic acid giving a fraction containing 19% nitrogen. They carried out a number of qualitative tests and came to the conclusion that the active principle was not a carbohydrate, protein or lipoid, a result which was also supported by Whipple and Robschiet Robbins. In a later paper, Cohn[22] and his coworkers concluded that the active principle is a nitrogenous base, the nitrogen in which exists, as in a secondary or tertiary amine, probably of the pyroll or pyridine group.

West and Nicholas[23] showed that the best fractions prepared contained 12–14% nitrogen and amino nitrogen 20% of the total nitrogen increasing up to 40% after acid hydrolysis. Iron and phosphorus were absent from their preparations while sulphur was found in traces. The fractions gave a positive biuret, diazo and naphthol test, a weak Hopkin's test and a slight lævorotation.

Felix and Fruhwein[24] have precipitated the active principle by adding to the aqueous extract mercuric sulphate in sulphuric acid solution. The active preparations contained at least 7% nitrogen, the amino nitrogen of which did not increase after acid hydrolysis. Their technique, however, suffers from the defect that the use of heavy metals renders the preparation partially inactive.

The researches of West and Howe[25] point to the fact that the active principle is composed essentially of two amino acids, Oxypyrrolin and Oxyglutamic acid, though their possible mode of linkage is still obscure.

The identificaion of the active principle with β-Hydroxyglutamic acid isolated from the liver was not supported by later work.[26] Similar negative results were obtained with glutathione found in liver by Robert Fleming.[27] Several amino acids were tested for their therapeutic value and although in one or two cases like arginine and sodium glutamate good results were obtained,[28] it was found in general that none of the usual essential amino acids[29,30,31] was individually responsible for the therapeutic action of liver.

Very recently, in May 1935, Dakin and West[32] have obtained a very active preparation by precipitating the commercial liver extract first by Reinecke salt and then by saturation with ammonium sulphate. 30 mg. of their product caused a perceptible reticulocyte response in pernicious anæmia patients. The clinical activity of the product was readily abolished by exposure to cold 0·5 N alkali, by boiling for one hour with 0·5 N sulphuric acid or by salts of heavy metals. On hydrolysis, the active material yielded an aminohexose and the following amino acids:— lysine (4.6%), arginine (13.5%), glycine (4.6%), leucine (20%), hydroxyprolin (10%), asparatic acid (17% and over), and glutamic acid (1.3%). It was also found that on hydrolysis with pepsin, the amino nitrogen did not increase; but on hydrolysis with erepsin, there was an increase in amino nitrogen while the product suffered from a loss of clinical activity. This shows clearly that the substance in question was a polypeptide. Its rough molecular weight was found to be 475–511 and optical rotation, $(L)_D^{20°} = -90°$.

In view of this probable simple polypeptide nature of the active principle, it appears possible to effect a concentration and purification of the extract by a process of adsorption followed by elution. Methods of simple ultra or electro-ultra filtrations of the extract through suitable membranes should also prove most useful in the purification of the active principle.

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[20] Elden and McCann, *Proc. Soc. Expt. Biol. Med*, 1927 **28**, **25**, 746.

[21] Jackson, H., Klein, L., and Wilkinson, J. F., *Biochem. J.*, 1935, **29**, 330.

[22] Cohn, E. J., McMeckin, T. L., and Minot, G. R., *J. Biol. Chem.*, 1930, **87**, xlix.

[23] Rudolph West, and Nicholas, E. G., *J. Am. Med. Assoc.*, 1929, **91**, 867.

[24] Felix, K., and Fruhwein H., *Z. Physiol. Chem.*, 1933, **216**, 173.

[25] West, R., and Howe, M., *J. Biol. Chem.*, 1930, **88**, 427.

[26] Rudolph West, and Howe, M., *J. Biol. Chem.*, 1931, **94**, 611.

[27] Robert Fleeming, *Biochem. J.*, 1932 **26**, 461.

[28] Drabkin, D. L., and Miller, H. K., *J. Biol. Chem.*, 1931, **90**, 531.

[29] Keil, H. L., and Nelson, V. E., *Proc. Iowa Acad. Sci.*, 1933, **40**, 103.

[30] Elvehjem and others, *J. Biol. Chem.*, 1931, **93**, 197.

[31] Giorgio Dominici, and Fansta Penati, *Minerva Med.*, 1931, **11**, 413.

[32] Dakin, H. D., and West, R., *J. Biol. Chem.*, 1935, **109**, 389.

ASSAY OF THE POTENCY.

In spite of the several attempts, there has been no simple and satisfactory method of assaying the potency of liver preparations in some measurable units. The development of a suitable method of biochemical assay would be of immense value not only for the progress of further investigations like the comparative study of the various livers for their antianæmic potency but also for the standardisation of dosages. The only reliable method that is now available is by an actual trial upon pernicious anæmia patients and noting the increase or otherwise of the erythrocytes and reticulocytes. But human cases not being generally available for experiment, progress in this direction is bound to be slow. Attempts at developing a simpler method by using animals have met with little success.

McGowan[33] has shown that pernicious anæmia in fowls accompanied by myelocytic proliferation of liver closely resembles the disease in human beings. He used 19 leghorn fowls, subjects of spontaneous attack of disease to determine the minimum dose of liver extract required to produce significant change in the blood picture. The extract was given orally as well as intraperitoneally. Though apparently good results were obtained, the method is only qualitative and needs to be confirmed.

The work of Vanghan *et al*[34] has shown that the administration of substances capable of alleviating pernicious anæmia in man produces a response in healthy pigeons similar to that occurring in clinical cases, thereby providing a biological test for the potency of these substances. Relatively pure liver preparations known to be effective in pernicious anæmia administered either by mouth or by intravenous injection gave consistent response by way of rapid increase in the circulatory reticulocytes and a pronounced gain in weight. Continuing the work of these authors, Edmunds *et al*[35] and Peabody and Neale[36] have outlined a method for testing the clinical value of liver preparations by observing their action on healthy pigeons. But when Wills,[37] Heiman *et al*[38] and Gurd[39] tried this method, they found spontaneous fluctuations even in control animals thus giving inconclusive results.

Jacobson[40] has attempted to use guinea pigs for the assay of the antianæmic factor and has even defined the minimum quantity (0·6 gm./Kgm. body wt.) as one guinea pig (G.P) unit.

Deusberg and Koll[41] adopted an *in vitro* method for testing the liver extracts for their potency. The active substance when added to hæmolysed human blood, destroys the active hæmoglobin spectrum and methamoglobin takes its place. The interfering substances like iron, sulphæmoglobin can be checked by adding suitable reagents. Deutsch and Wilkinson[42] have recently shown, however, that this method cannot be relied upon since no correlation can be obtained between the clinical activity and methamoglobin production. If it is possible to develop this method, it would no doubt offer advantages over other clinical tests ; it would give quick results even with small quantities of the substances.

The production of the actual pernicious anæmia in animals has not been achieved so far. Since there are two factors involved in the etiology of pernicious anæmia it would perhaps be possible to produce the disease by controlling one or the other of these two factors. The most logical way of achieving this, would probably be, by means of a suitable diet. McCarrison[43] has shown that different diets would produce different influences on the gastro-intestinal tract. It remains to be proved by future experiments whether a defective gastric secretion thus produced would not lead to the production of pernicious anæmia. Miller and Rhoads[44] have tried a certain diet on guinea pigs and have produced a disease corresponding

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[33] McGowan, J. P., *Arch. Intern. Med.*, 1932, **49**, 26.

[34] Vaughan, J. M., Muller, G. L., and Zetzel, *Lancet*, 1930, **218**, 1062.

[35] Edmunds, Bruckner, and Fritzell, *J. Am. Pharm. Assoc.*, 1933, **22**, 91.

[36] Peabody, W. A., and Neale, R. C., *J. Am. Pharm. Assoc.*, 1933, **22**, 231.

[37] Wills, *Brit. J. Exp. Path.*, 1932, **13**, 172.

[38] Heiman, Connery and Goldwater, *Am. J. Med. Sci.*, 1934, **188**, 343.

[39] Gurd, M. R., *Quart. J. Pharm. and Pharmco.*, 1935, **8**, 39.

[40] Jacobson, B. M., *Science*, 1934, **80**, 211; *J. Clin. Invest.*, 1934, **13**, 714.

[41] Deusberg, R., and Koll, W., *Arch. f. Exper. Path.*, 1931, **162**, 296.

[42] Deutsch, W., and Wilkinson, J. F., *Brit. J. Expt. Pathol.*, 1935, **16**, 33.

[43] McCarrison, Robert, "Studies in Deficiency Disease," Henry Frowde, Holder and Stoughton, London, 1921.

[44] Miller, D. K., and Rhoads, C. P., *J. Clin. Invest*, 1935, **14**, 153.

to canine Black Tongue. Specific improvement is noticed in such cases when liver extract is administered. It should, therefore, be a very fruitful line of investigation to try and produce pathological conditions in animals similar to pernicious anæmia by controlling the diet and then test the effect of liver preparations on them.

Another promising line of enquiry into the assay of the antianæmic materials would probably lie in estimating one or two of the component amino acids of the potent polypeptide before and after its hydrolysis. Since the purest preparation of Dakin and West has been shown to contain arginine to the extent of 13·5% and asparatic acid, more than 17%, it should be possible to obtain an idea of the concentration of the active polypeptide by estimating one or both the above constituents. Work in this direction might yield results of great practical utility in the assay of the active principle.

Economic Ornithology in India.

By Sálim Ali.

(*Ornithologist, Dehra Dun.*)

A CHARGE that has been preferred against ornithologists in India, perhaps not altogether without reason, is that they have been, and are, far too busy "classification-mongering", *i.e.*, quibbling over morphology and taxonomy, to bother about the *living* bird. Upto a point it may be argued in their defence that before biological studies on any group of animals can be undertaken it is essential that the forms belonging to that group should first be properly classified and made cognisable. But while acknowledging the stirling work done in this direction by ornithologists—wholly European—during the last century and still being carried on by their torch-bearers to-day, there is no doubt that the various other aspects of Indian ornithology have suffered a corresponding neglect.

The Indian Empire encompassing as it does an infinite diversity of climates and physical features—ranging from the eternal snows of the Himalayan peaks to the torrid deserts of Rajputana and Sind—contains an avifauna that for richness and variety can scarcely be rivalled by areas of similar size elsewhere in the world. The total number of species and sub-species so far described is just over 2,350 (including about 350 winter visitors) and more are being added to the list as fresh material from insufficiently worked areas or groups becomes available. Notwithstanding this prodigality of material, our knowledge of the living bird in India is surprisingly meagre. Beyond the barest facts about the nests and eggs of most (but still not all) of them, we know practically nothing concerning their breeding biology. The study of migration—one of the most engrossing of bird activities and one that has stirred Man's wonderment from the earliest times—is here still in its veriest infancy compared with the researches and the strides being made in Western countries. Bird ecology, despite the vast natural facilities, remains practically an untouched and virgin field, while Economic Ornithology —an aspect of bird study that should have been, if for purely materialistic reasons, one of the foremost to receive attention in an agricultural country like India, has not even been scratched on the surface.

Besides being a source of direct food supply to millions of human beings in this country, it is little realised that wild birds stand in a class by themselves—second only, if at all, to predaceous and parasitic insects—as destroyers of, and natural checks on, harmful insect pests and other vermin, and as agents in the cross-pollination of flowers and the dissemination of seed. Directly or indirectly they exert their influence in practically every branch of human industry.

Economic Ornithology is the science that concerns itself with striking a precise balance between the damage caused by birds to Agriculture, Horticulture, Forestry and other human interests as against the active benefits they confer in less obvious ways. An increasing amount of importance is being attached in recent years to this science in Europe and America with excellent and far-reaching results. In the United States there is a well-organised department carrying on continuous and intensive research work on the life-histories of birds with special reference to their food and feeding habits under the Bureau of Biological Survey, a subsidiary

branch of the U. S. Department of Agriculture.

The only attempt systematically made with the object of evaluating the economic status of birds in this country was an investigation on the food of certain birds by Mason and Lefroy at Pusa. The results, published as a *Memoir of the Department of Agriculture in India* (Vol. III, Entomological Series, 1912), while meagre in extent and circumscribed in scope, demonstrate the vast possibilities and usefulness of this type of research in India. Their weakness lies in the fact that they deal only with adult birds whose diet we know often differs completely from that of juveniles. In Fringilline birds for instance—the tribe to which our common Sparrow belongs—the food of the young consists almost entirely of caterpillars, moths and other soft-bodied insects while that of the adults is almost exclusively seeds and grain. The investigations fail to appraise the *whole* value or status of the birds since they completely overlook this phase of their life-histories. Besides, it is felt that the studies that have been made by an analysis of stomach contents in different months of the year cannot really be appreciated without a knowledge of the density of the bird population on areas of various types and at different seasons. The taking of bird censuses has not been carried out anywhere in India at all. A number of methods for doing this have been employed successfully in Europe and America, none of which could perhaps be applied in their entirety to Indian conditions but which it should not be difficult to adapt. Active co-operation would be necessary from a band of workers, whom it should be possible to find among the biology undergraduates of our various colleges and universities. Tracts of from 40 to 80 acres have been found to be conveniently controlled by one person, but in many areas in India, owing to the density of bird population and other factors, 20 to 25 acres will probably be found to be a more suitable unit. Counts are made at frequent intervals of all birds present in the controlled areas and also of the breeding population of certain selected species over much larger areas by counting their nests.

The study of bird movements is also obviously important from the economic point of view, and it is thought that investigations of methods of catching birds for marking would lead to greater numbers being marked and thus to more rapid progress in our knowledge of their movements. The method of marking or "banding" birds has been widely employed in Europe and America since the beginning of the present century, but perhaps more systematically and intensively after the War. It consists of fixing on the leg or tarsus of a bird of an aluminium ring of appropriate size on which is stamped a serial number and the address of the ringer. A register is kept by the ringer in which are noted down the species, date of marking, sex, age and other particulars of the ringed bird against the corresponding serial number. The bird is then released, the idea being that if it is subsequently shot or captured the particulars of the date and place of taking and other details would be communicated by the recoverer to the address on the ring. By a recovery of ringed birds in sufficient numbers and a collation of the data it has been possible to build up a great deal of invaluable information concerning the migration and local movements of many species, the age to which they live and other details of their individual life-histories impossible to obtain in any other way.

It will be seen, therefore, that Economic Ornithology does not merely end with the ripping open of the stomachs of birds and listing up their contents, but involves a great complexity of other investigation and study besides. Mason and Lefroy's paper is an attack on but one facet of a many-sided problem, though admittedly the most important contribution that has yet been made to the subject in India. It may be mentioned, however, that the numerical method which C. W. Mason principally employed and the merits of which he so strongly advocates, *i.e.*, of reckoning stomach contents of birds solely by the number of individual insects or seeds, has been well shown by Mr. W. L. McAtee[1] to be vague and often insufficiently illuminating. The principal objection to the numerical method is that it takes no account of the size of the objects eaten and hence conveys no idea to those unacquainted with the groups concerned of the relative importance of the food elements. On the other hand, under the volumetric method which has been in continuous use by the Biological Survey of the U.S. Department of Agriculture since 1895, the proportions the various food elements contribute to the bird's subsistence

[1] W. L. McAtee, "Methods of estimating the contents of Bird Stomachs," *The Auk*, Oct. 1912, **29**, No. 4.

are evident at a glance and the bird's capacity for good or harm are clearly indicated. Both methods have their weak points, however, and Mr. McAtee suggests that the ideal technique is one that combines the good points of both the numerical and the volumetric methods.

The following, in general terms, are the harmful and beneficial activities of birds:

Harmful (H):

1. Damage to cereal crops, fruit, vegetables, etc. and destruction of useful insects, fish, etc.
2. Intermediate hosts of parasites which may be dispersed far and wide by their migrational movements and spread diseases among Man and Animals.
3. Dispersal of noxious weeds, etc

Beneficial (B):

1. Destruction of insect pests, refuse, rats, mice and other vermin which are not only destructive to agriculture and other branches of human industry, but carriers of diseases of Man and Animals.
2. As agents of cross-pollination of flowers and dispersal of seed, and hence as regulators of vegetation.
3. As source of supply of meat, feathers, guano and other useful and commercial products.

To take these various activities in some detail:—

(*H*) 1.—Crows, Mynahs, Parakeets, the Fringilline birds and others cause damage to ripening crops of Maize, Jowari, Bajri, Wheat, Paddy, etc., which is occasionally considerable in extent. Migratory ducks, coots, geese and cranes do extensive damage in certain areas to rice, gram, wheat and other crops. From a scrutiny of the stomach contents and feeding habits of Rosy Pastors in the Nander District of Hyderabad recently, it was estimated[2] that a flock of 400 birds would account for 25 lbs. of Jowari in one day, equivalent to the food of an average villager for 10 to 12 days! As there are thousands of these birds continuously at work all through the ripening period of Jowari, it is not difficult to realise the magnitude of the damage they cause. Mr. K. V. Joshi, Deputy Director of Agriculture, Bombay Presidency, roughly estimates that the damage done by these birds to cereals in some talukas of S.-E. Khandesh is about 15 per cent. of the total crop.

Crows, Mynahs, Starlings, Parakeets, Bulbuls and Barbets are some of the principal despoilers of orchards and vegetable gardens. Mangoes, apples, pears, plums, peaches, cherries, litchies, guavas, tomatoes, green peas, etc., are some of the more important sufferers.

Bee-eaters occasionally do some damage by destroying honey bees, but this is on the whole negligible. Aquatic birds have important relations with the fishing industry. Grebes, Cormorants, Herons, Gulls and Kingfishers have often been accused and convicted for causing serious reduction of food fishes, but a careful study of their food habits by the Biological Survey of the U. S. Department of Agriculture has demonstrated that only a small proportion of their diet consists of such fishes, their staple food being crawfish, crustaceans and insects some of which are more injurious to the fry of food fishes than the birds themselves. Trout fry studies by the Biological Survey reveal that the greatest amount of disappearance, which less careful observers are inclined to attribute to birds, is caused by enemy or competitor fishes. Few realise what serious destroyers of spawn there are among the fish themselves, which have frequently well-developed cannibalistic tendencies. Larvæ of water beetles, nymphs of dragonflies, water-bugs and crayfish are some of the worst offenders. Birds eat all these and on the whole probably more than compensate for any direct loss they may cause to the fry. Moreover, most edible fishes of any value live in deeper water and are, therefore, immune as a rule from depredations by Herons, Egrets, etc., who keep close to the shore and devour whatever can be most easily procured. In this way they sometimes eat numbers of catfish which are indeed notorious spawn eaters. Fish-eating birds do most damage about hatcheries as has been the experience during the introduction of trout into the Nilgiris and Kashmir, and here their numbers need to be controlled.

(*H*) 2.—Very little work has so far been done even in Europe and America—and practically none in India—on the subject of the dispersal by birds of diseases of Man and Animals. It is an investigation pregnant with possibilities and obviously of the greatest importance to health and sanitation as well as to animal husbandry and agriculture, especially as birds are well

[2] Sálim Ali, "The Hyderabad State Ornithological Survey," *Jour. Bom. Nat. Hist. Soc.*, **1933, 36,** 365.

known to be the hosts of a large variety of both ecto- and endo-parasites which their far-flung wanderings may help to disperse. Thus Sparrows introduced into North America are responsible—or at least blamed—for spreading among poultry certain diseases such as "Blackhead" due to parasitic Coccidea. Some of the worms found almost exclusively in birds belong to the following classes: Trematoda, Cestoda, Nematoda, Acanthocephalidæ and Pentastomidæ. Among the Arthropoda several forms of Acari are known to be ecto-parasites of birds, and among insects numerous forms of Aphaniptera, Rhynchota, Diptera and Mallophaga are prominent.

Of the Trematodes and Acanthocephalidæ many need two intermediate hosts, the last of which forms the principal food of the birds. For example, one common Trematode of the gut of *Hirundinidæ* (Swallows) and *Micropodidæ* (Swifts)—*Plagiorchis maculosus* Rudolphi—has in the larval or miracidium stage to enter a fresh-water snail (*Limnæa*) where it multiplies parthenogenetically. The cercariæ leave the host by hundreds and find their way into the larvæ of mosquitoes (*Chironomis*, etc.), survive the insects' metamorphosis and are swallowed along with the host by swallows and swifts. They develop and reach sexual maturity in the small intestine of these birds, the eggs being passed out with the fæces of the hosts and requiring to reach the water for their development.[3]

(*H*) 3.—No better instance of the harm done by birds in the dispersal of noxious weeds can be cited than the phenomenal spread in India of that pernicious exotic weed *Lantana camara*. This plant, of Mexican domicile, first imported into Ceylon for ornamental purposes just over a hundred years ago, has since overrun thousands of square miles of the peninsula and become the despair alike of agriculturist and forester. Its widespread dispersal within such a comparatively short period would have been impossible without the agency of birds, numerous species of which extensively devour its berries which the plant everywhere produces in overwhelming profusion. I have observed an Oriole (*Oriolus kundoo*) swallowing 77 berries in the course of 3 minutes! The seeds pass through the birds' intestines unaffected (negatively at least) by the gastric secretions and out with the fæces, germinate rapidly under favourable conditions and establish themselves.

Another plant that does considerable damage to trees of many kinds both in forest and orchard, causing financial loss to the mango-grower which, were it possible of assessment, would run into lakhs of rupees annually, is the *Loranthus* tree-parasite. It belongs to a family, well represented in India, almost all of whose members are more or less wholly symbiotic with Sunbirds (*Nectariniidæ*) and Flowerpeckers (*Dicæidæ*) and other species which both fertilise its flowers and disperse its seeds.[4]

Having dealt briefly with some of the actual as well as hypothetical or alleged harm from which man suffers or may suffer at the hands of birds, it is fitting to discuss some of their activities which are decidedly beneficial to his interests.

(*B*) 1.—It has been observed by the French writer Michelet that the Birds could exist without Man, but that Man would perish without the Birds, and Buckland[5] observes that "But for the trees the insects would perish, but for the insects the birds would perish, and but for the birds the trees would perish: and so follow the inexorable laws of nature to the conclusion of their awful vengeance, but for the trees the world would perish." An impartial analysis of the evidence, both direct and circumstantial, shows that there is, indeed, little extravagance in either of these statements. The number, fecundity and voracity of insects are unbelievable. Over 300,000 forms have been described and it is considered not improbable that twice that number still remain to be described. In the Indian Empire alone more than 30,000 forms are known. Practically all living animals as well as most plants furnish food for these incomputable hordes. Many estimates have been made of what a single pair of insects would increase to if allowed unchecked multiplication, and astounding figures have been reached, rivalling in their stupendousness those which we associate with astronomical calculations. A Canadian entomologist estimated that a single pair of

[3] Stresemann, E., *Handbuch der Zoologie-Aves.*, Berlin, 1933, p. 712.

[4] Sálim Ali, "The Rôle of Sunbirds and Flowerpeckers in the Propagation and Distribution of the Tree-parasite *Loranthus longiflorus* Desr. in the Konkan," *Jour. Bom. Nat. Hist. Soc.*, **35**, 145-49.

[5] Buckland, James, "The Value of Birds to Man," *Ann. Rep. Smithsonian Inst.*, Washington, 1913, 439-58.

Colorado Beetles or Potato Bugs *Leptinotarsa decemlineata* (belonging to the prolific family *Chrysomelidæ* of which over 20,000 species have been described and which is well represented in India) would, without check, increase in one season to sixty millions. Riley computed that the Hop Aphis or Chinch Bug *Blissus leucopterus* (Order *Hemiptera*, Fam. *Lygæidæ*), very destructive to grasses and cereals in America, which develops 13 generations in a single year, would, if unchecked, reach ten sextillion individuals at the end of the 12th generation. Forbush calculates that if this brood were marshalled in line end to end at the rate of 10 per inch, the procession would be so long that light travelling at the rate of 184,000 miles per second would take 2,500 years to reach from one end to the other!

A caterpillar is said to eat twice its own weight in leaves per day. According to Forbush certain flesh-feeding larvæ will consume within 24 hours, 200 times their original weight. Trouvelot who made a special study of the subject, affirms that the food taken by a single silkworm in 56 days equals in weight 86,000 times its original weight at hatching.

The fecundity and voracity of locusts are well known. Their swarms are at times so thick as to obscure the sun and where an extensive swarm alights, green and prosperous areas are frequently converted into a desolate tract with bare stems in the course of a few hours. The female locust lays its eggs in capsules underground, each capsule containing about 100 eggs and several of these capsules are laid by each individual. On a farm in South Africa measuring 3,300 acres no less than 14 tons of eggs have been dug up at one time, estimated to have produced 1,250 million locusts. Birds not only take heavy toll of the marauding hordes, but also scratch up and devour the eggs in vast quantities as well as the different stages of the insects' metamorphosis. The White Stork (*Ciconia ciconia*) is a great destroyer of locusts, and many birds such as the Rosy Pastor (*Pastor roseus*) live and feed their young exclusively on these insects in their common breeding grounds.[6]

A large proportion of the normal food of numerous birds consists of insects including many that are in the highest degree injurious to Man and his concerns. Many young birds in the first few days of their lives consume more than their own weight of food in 24 hours. A pair of starlings have been observed to bring food to their nestyoung (caterpillars, grasshoppers, locusts etc.) 370 times in a day, and according to Dr. W. E. Collinge, the well-known British authority, House Sparrows bring food (caterpillars, soft-bodied insects, etc.) from 220 to 260 times per day. A German ornithologist has estimated that a single pair of Tits with their progeny destroy annually at least 120 million insect eggs or 150 thousand caterpillars and larvæ. This warfare is waged not only when insects are at the peak of their periodical abundance but incessantly, relentlessly and in all stages of the insects' lives. Therefore, where birds have not been unwisely interfered with they constitute one of the most effective natural checks upon insect numbers.

Vultures, Kites and Crows are invaluable as scavengers. They speedily and effectively dispose of carcases of cattle and other refuse lying in the precincts of Indian villages—notoriously lacking in any system of sanitation—that would otherwise putrify and befoul the air and become veritable culture-beds of disease. Their services are of particular importance during epidemics of cattle diseases when large numbers of animals perish and even when buried as compelled by Regulations, are no more than covered over with a flimsy layer of earth to be exhumed by the first prowling jackal that happens to come upon the spot. The swiftness with which a party of vultures will dispose of carrion is amazing. I once timed them on the carcases of 2 sloth bears which, after being skinned, could not have weighed less than 250 lbs. between them. Within a space of 40 minutes nothing but picked bones remained, this being the work of 50 to 70 vultures.

Owls, Kestrels, Hawks and the birds of prey generally—so often stigmatised as destructive to poultry and game and slaughtered out of hand—are amongst the most important of nature's checks upon rats and mice, some of the most fecund and destructive pests from which Man and his works suffer. They do enormous damage to crops and agricultural produce, and are besides the carriers directly or indirectly of diseases often fatal to Man. Any one acquainted with the ravages of the Sind Mole Rat (*Gunomys sindicus*) in the rice-growing tracts of the

[6] Serebrennikov, M. K., "Der Rosenstar (*Pastor roseus* L.), seine Lebesweise und ökonomische Bedeutung in Uzbekistan (Turkestan)," *Jour. für Orn.*, 1931, **79**, 29-56.

Indus Delta in Lower Sind—varying from 10 to over 50 per cent. of the paddy crop[7]—will readily appreciate the truth of this.

It has been calculated that one pair of rats having six litters of 8 young annually and breeding when 3½ months old, with equal sexes and no deaths, would increase at the end of the year to 880 rats. The unchecked increase of a pair in 5 years has been computed at 940,369,969,152 rats.[8] The Sind Mole Rat also breeds throughout the year. The number of young born in a litter is 5 to 10, but in October and November the litters are very large varying from 14 to 18 young each. Mice are equally fecund. The sex season of the female is a very long one and the period of gestation as short as from 12 to 21 days. The usual litter is 5 to 6 young, and the female is ready to breed again soon after parturition.

Calculations such as the above, however, are purely theoretical and their results will never be approached in Nature, but it is pointed out that they are not extravagant *qua* the power to reproduce and are based upon moderate and conservative estimates. It will be seen that every pair of rats destroyed by birds means the annual suppression of a potential increase of 880 rats. Most of the birds named above feed largely on rats and mice, and some of the owls more or less exclusively on them. In the stomachs of Horned Owls (*Bubo bengalensis*) I have frequently found the remains of 2 or 3 rats or mice, and as digestion in birds is a continuous and rapid process, it is conceivable that a larger number may be destroyed in the course of 24 hours. Since these birds are engaged in the good work from year's end to year's end, some idea of their beneficial qualities may be obtained.

(*B*) 2.—While the importance of bees, butterflies and a host of other insects in the cross-fertilisation of flowers is well known, the significance of birds in the same capacity has not been adequately recognised. A large number of birds of divers families and species are responsible for the cross-fertilisation of flowers, many of them possessing special adaptations in the structure and mechanism of their tongue and bill for the purpose of extracting honey from the base of the flower-tubes. Flower-nectar is rich in carbohydrates and provides excellent nutriment, so much so that many of the most highly organised flower-birds subsist more or less exclusively on this diet. In trying to reach the nectar, the forehead or throat of the bird comes into contact with the anthers. The ripe pollen adheres to the feathers and is transported to the mature stigma of the next flower which it thus fertilises. It is little realised how largely responsible birds are for the success of the present-day match industry in India. Of all the indigenous woods that have been tried for the manufacture of matches, that of the Silk Cotton tree (*Bombax malabaricum*) has been found to be the most satisfactory both as regards quality and abundance. The large crimson flowers of this species contain a plentiful supply of nectar and are mainly cross-pollinated by birds who thus contribute to the production of fertile seed and thereby to the continuance of healthy generations of the tree.[9] Practically no research on these lines has been carried out in India and it will probably be found that we are ultimately dependent upon birds in this House-that-Jack-built sort of way for many of our everyday requirements.

(*B*) 3.—No one who has visited the larger *dhands* or *jheels* in Sind and other places in Northern India during the cold weather can have failed to remark upon the magnitude of the netting operations that go on throughout this season for supplying the markets of the larger towns, both near and distant, with wildfowl of every description for the table. The inhabitants of the neighbourhood subsist during these months more or less exclusively on the flesh of these birds or on the trade in them. Round every village near a *dhand* of any size in Sind may be seen little mounds of coot feathers which furnish some indication of the esteem the birds enjoy as an article of diet. The wildfowl netting on the Manchar Lake alone must involve a turnover of several thousand rupees annually, besides providing countless inhabitants of the neighbourhood with free or almost free sustenance for several months in the year. Wild ducks, geese, coots, etc., were debited further up in the course of this account with damage to paddy and other crops. The netting operations against them and the profits accruing therefrom, now

[7] Wagle, P. V., "The Rice Rats of Lower Sind and their Control," *Jour. Bom. Nat. Hist. Soc.*, 1927, **32**, 330.

[8] Hinton, M. A. C., "Rats and Mice as Enemies of Mankind," British Museum (Natural History), Economic Series No. 8, London, 1920.

[9] Sálim Ali, "Flower-Birds and Bird-Flowers in India," *Jour. Bom. Nat. Hist. Soc.*, 1932, **35**, 573.

provide an item to their credit which probably far outbalances the harm they do. Rosy Pastors are also greatly relished as an item of food and thousands upon thousands are netted or slaughtered every year in North-west India and elsewhere during the autumn and spring migrations, especially the latter as the birds are then very fat.

The working of the Wild Birds and Animals Protection Act and similar measures has put a check upon the exploitation of birds for the plumage trade. Feathers are largely used in the millinery business and although modern trend in women's fashions has for the time being made them less popular than they were some years ago, there is still a vast and lucrative demand from abroad, both the Eastern countries and Europe. With a scientific determination of the economic status of various species of our commoner birds and a regulated system of controlling the numbers of the more or less undoubtedly harmful ones, such as the parakeets apparently are, there is no reason why the plumage trade should not be legitimised and even encouraged to become a fruitful source of revenue, which could be earmarked for the furtherance of research in Economic Ornithology and for measures of conservation. Apart from revenue considerations, the legalisation of the plumage trade under an officially regulated and controlled system would give fillip to the farming of certain birds such as egrets for the sake of their valuable plumes. Egret-farming is a potentially profitable cottage industry extensively practised at one time by the lacustrine section of the population in Sind. It is now dwindling in importance owing to the complete ban on exports of feathers to foreign countries and the consequent narrowing down of the market to local demand chiefly in Calcutta.

A few years ago certain suggestions were put before the local government by the Bombay Natural History Society for the permitting of export under officially certified and sealed packages of egret feathers produced in these farms in order to revitalise the industry, but as far as is known the suggestions have not been given effect to.

There are other minor products of birds which, if properly husbanded, could be made to yield considerable revenue in India. The saliva nests of the Edible Swifts (*Collocalia*) which breed in vast colonies in caves on islands off the Burma coast are even now the source of a considerable income to the Government. They are collected and exported to China as a table delicacy and the better qualities fetch from 10 to 20 dollars (= approximately Rs. 8–4–0 to Rs. 16–8–0) per catty ($1\frac{1}{3}$ to $1\frac{1}{2}$ lb.). The value of nests imported into China during 1923, 1924 and 1925 exceeded a million tael (Rs. 25,00,000). More than half this amount came from the port of Shanghai, mostly from Singapore, Java and Hongkong but also from India and French Indo-China.[10]

Guano, which is really the excrement of sea birds such as gannets, cormorants and pelicans, is another product of great commercial value. The fertilising properties of the phosphoric acid and nitrogen contained in fish was not recognised until guano became a stimulus to intensive agriculture. The real guano is found in vast stratified accumulations on islands off the Peruvian coast, and although no deposits of anything like the magnitude or value of those on Chincha Island exist within our limits, still the sources and possibilities of the "guano" of colonial nesting birds have not been sufficiently explored in India.

CONCLUSION.

Sufficient examples have been given to show that a scientific investigation of the life-histories of birds generally is worthwhile from the economic point of view. The potentialities of research in Economic Ornithology in an agricultural country like India are unbounded. In its bearings and ramifications the subject is in no wise less important than Economic Botany or Economic Entomology which, under official recognition, have already made such good progress in this country. It is suggested that research in Economic Ornithology should also be similarly encouraged. It should be taken up in earnest by the Imperial Council of Agricultural Research under whose ægis it should become an All-India—or under the impending reforms, a Federal—function as it is in the U.S.A. The migrations of birds, in addition to their ordinary free movements, carry them to all parts of the country, and therefore the only adequate survey of their economic relations can be the one that takes in their entire range regardless of provincial boundaries.

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[10] Sowerby, Arthur De C., "The Edible Birds' Nest Swift," *China Journal*, March 1931, **14**, 135-137.

Centenaries in January 1936.

Lagrange (Joseph Louis), 1736-1813.

TWENTY-FIFTH of January 1736 saw the birth at Turin of one of the greatest French mathematicians. At school his boyish interests were Homer and Virgil. At the age of seventeen, he chanced to read Halley's *A new, exact and easy method of finding the roots of any equations generally, and that without any previous reduction*, published in 1694 in volume 18 of the *Philosophical Transactions* of the Royal Society. This kindled the mathematical spark in him. Like Newton, but at a still earlier age, he reached to the heart of the matter in an incredibly short time.

INVENTS CALCULUS OF VARIATIONS.

In these days when our Universities and Departments of Education are vying with one another in fixing absolutely rigid age limits for admission to the University, it is specially interesting to note that at the age of 18, Lagrange was appointed professor of mathematics in the Royal School of Artillery at Turin. When he was but 19, his attack on the isoperimetrical problem led to his invention of the new *Calculus of Variations*. This Calculus is intimately related to the story of Least Action which began with the reflecting mirrors of Hero, interested Descartes, led to Hamilton's principle and is still persisting to-day in the development of Wave Mechanics.

FOUNDS TURIN ACADEMY.

In 1758, he was at the head of a youthful band of scientists who became the foundation members of the Turin Academy of Sciences and he contributed several papers to the *Miscellanee Taurinensia*, which was the organ of the Academy. He was awarded the prize of the French Academy of Sciences in 1764 for an essay on the *Libration of the Moon* in which he used his well-known equations for the first time. He won this prize in several later years, *viz.*, 1766, 1772, 1774 and 1778.

SUCCEEDS EULER.

In 1776, the great Euler of the Academy of Berlin recommended him to be appointed his successor. Frederick the Great accepted the recommendation with the remark that "The greatest king of Europe" should have "the greatest mathematician of Europe" in his court. While at Berlin, Lagrange contributed several learned papers, which culminated in the *Mechanique analytique*, which Hamilton described as "scientific poem". This was published at Paris in 1788 under the supervision of Legendre.

SETTLES IN FRANCE.

After the death of Frederick the Great, Lagrange accepted the invitation of Louis XVI to Paris. He was lodged in Louvre with a pension of 6,000 francs. In 1791 he was elected foreign member of the Royal Society of London. He commanded universal respect even in the crisis of the Revolution. He was one of the first members of the Bureau des Longitudes. He supported the adoption of the decimal and metrical system. When someone defended twelve because it has more factors, Lagrange remarked what a pity it was that the number eleven had not been chosen as the base, because it was prime.

LAST YEARS.

In his later life, mathematicians thronged to meet him and to show him every honour, but they were dismayed to find him distracted, melancholy and indifferent to his surroundings. The years of activity had told; and Lagrange was mathematically worn out. He directed his thoughts elsewhere—to metaphysics, religion, medicine and chemistry. He found chemistry, however, to be as "easy as algebra". He began his revision of his *Mechanique analytique* in 1810; but did not live to complete the revision. He died at Paris, 10th April 1813.

In the words of Turnbull "Lagrange is one of the greatest mathematicians of all times not only for the abundance and originality of his work, but for the beauty and propriety of his writings." His complete works were edited by Serret and Darboux and were published in fourteen sumptuous volumes between 1867 and 1892. His biography published in the *Memoires de l'Institute*, by Delambre in 1812 is reproduced in Volume I of the collected works. The last two volumes are also of biographical interest as they contain his correspondence with the chief mathematicians of his time such as Clairaut, D'Alembert and Euler.

S. R. RANGANATHAN.

Watt (James), 1736-1819.

SIX days before Lagrange was born, one of the front rank engineers, whose inventive talents have conferred immeasurable benefits on the human race, was ushered into the world at Greenock in Scotland. James Watt was jeered by his school fellows as being dull and spiritless. But even in his sixth year, he was solving geometrical problems, experimenting with a tea kettle and drawing machines. His father was a mathematical instrument maker and he was 'a diligent worker in his father's shop and gave early evidence of his manual dexterity'.

His Early Chances.

Having spent a year as an apprentice to John Morgan, the "philosophical instrument maker", he went to Glasgow in 1756 and tried to establish himself as an instrument maker. But the city guilds prevented this on some formal grounds. It was at this juncture that the University of Glasgow came to his assistance by appointing him as a mathematical instrument maker to the University and by allowing him to establish a workshop within its precincts. Here he worked from 1757 to 1773 and made the acquaintance of eminent men such as Joseph Black, the discoverer of latent heat. Here also, in 1764 occurred the well-known incident of the repair of the model of a Newcomen steam engine, belonging to the University.

His Invention.

While repairing this engine, he calculated the abnormal loss of heat and was filled with an ardent desire to reduce the heat losses. This desire was working in his mind till, one day in 1765, the fertile idea of the condenser appeared. The phase of sudden revelation, which followed several weeks of unconscious work, is best described in his own words. "It was in the Green of Glasgow. I had just gone to take a walk on a fine Sabbath afternoon. I had entered the Green by the gate at the foot of Charlotte Street—had passed the old washing house. I was thinking upon the engine.....and gone as far as the Herd's House, when the idea came into my mind that as steam was an elastic body it would rush into a vacuum, and if a communication was made between the cylinder and an exhausted vessel, it would rush into it and might be there condensed without cooling the cylinder. I then saw that I must get quit of the condensed steam and injection water, if I used a jet as in Newcomen's engine. Two ways of doing this occurred to me. First the water might run off by a descending pipe, if an offlet could be got at a depth of 35 or 36 feet, and any air might be extracted by a small pump; the second was to make the pump large enough to extract both water and air..... I had not walked further than the Golf House when the whole thing was arranged in my mind."

The invention was made. It remained to be completed by new experiments. A series of condensers were made, each more perfect than its predecessor, until the first large-scale engine was erected near Linlithgow and the first patent was obtained in 1769.

Soho Ironworks.

In 1775, Watt entered into partnership with Mathew Boulton of Soho near Birmingham, when the manufacture of the condensing steam engine was commenced on a large scale. This partnership was a fortunate one for Watt — Boulton was bold and enterprising; Watt was timid and shrank from the commercial side of affairs.

Last Years.

He retired from business in 1800. But he showed the same alert and active mind even after retirement. His last work was the invention of machines for copying sculpture. We find him not many months before his death—the end came on August 19, 1819—presenting copies of busts to his friends as the work "of a young artist just entering on his eighty-third year".

The attic room of his house—the Watt Room—where he used to work alone is still preserved in its old condition. An exhaustive account of his many inventions is given by Edward A. Cowper in the pages of the *Proceedings of the Institution of Mechanical Engineers* for 1883.

In the field of pure science, Watt's paper entitled *Thoughts on the constituent parts of water and of dephlostigated air, with an account of some experiments on the subject* and published in the *Philosophical Transactions* of 1784 gives him the claim as a discoverer of the composition of water.

S. R. Ranganathan.

Letters to the Editor.

The Electric Discharge in Gases and the Debye-Hückel Theory.

IN view of the remarkable success of the Debye-Hückel theory in the field of the kinematics of ions in liquid media, it is not a little surprising that but little use of its methods has been made in the analysis of the phenomena in the discharge tubes. The object of the present note is to direct attention to a possible treatment of the familiar cathode-fall effects from the standpoint of the theory.

It is easily shown that even in the intense[1] type of electric discharge the condition of the gas at these low pressures is analogous to that of an electrolytic solution at great dilutions. For simplicity, the case of singly charged positive and negative ions will be considered here. Making the same assumptions as made by Debye-Hückel[2] in the development of their theory, we arrive at a similar differential equation:

$$\text{div grad. } V = \nabla^2 V = K^2 V \quad .. \quad (1)$$

for which a solution is now sought, having cylindrical symmetry. In the above equation K is a constant and V is the potential at any point (r,z,ϕ), V being supposed to be such that power terms of $\frac{eV}{kT}$ higher than the first can be neglected (where e, k and T have their usual significance) *i.e.*, V $\not>$ 30 kv for ordinary temperatures.

The solution obtained is

$$V = [\, A + A' e^{Kz}\,][\, B - \frac{B' r^2}{c^2} - \ldots\,] \quad (2)$$

where c is the radius of the discharge tube and A, A', B and B' are constants, to be evaluated from initial conditions. The conditions of the problem are assumed to be such that when $z = 0$, $V = 0$, $\left(\frac{\partial V}{\partial z}\right)_{z=0} = 0$.

Applying this equation to the variation of the length of the cathode-fall with the voltage-drop across it, it will be easily seen that the former will vary as the logarithm of the latter. This is actually found to be the case as a first approximation, in the experiments on cathode-fall length for varying voltages using positive rays of hydrogen.[3]

The theory can easily be extended to take into account the different types of ions present, the effect of the space charge at the cathode, the perturbation of the equilibrium conditions due to the passage of the current, etc., to be treated elsewhere.

In the end, it should be remarked that the chief value of the Debye-Hückel procedure lies in the fact, that it does not contemplate any specific kinematical picture of the reactions going on in the system, but makes use of only general statistical methods.

Physical Laboratory, V. T. CHIPLONKAR.
Benares Hindu University,
December 19, 1935.

[1] Townsend, J. S., "Electricity in Gases," Oxford, 1915; Millikan, Gottaschalk and Kelly, *Phys. Rev.*, 1920, **15**, 157.

[2] Taylor, H. S., "Treatise on Physical Chemistry," Macmillan & Co., Second Edition, **1**, 785.

[3] Dasannacharya, B., and Das, G. K., *Proc. Ind. Sci. Cong.*, 1936, Indore, Phys. and Math. Section.

A Zonal Effect in the Electrolytic Coagulation of Colloid Manganese Dioxide.

EARLIER results[1] for the viscosity changes consequent upon the *slow* coagulation of a number of sols have shown the difficulty of reconciling experimental results with the chief assumption made in Smoluchowski's theory[2] of the kinetics of coagulation, *viz.*, that the change is but a time continuous coalescence of the micella. An additional support to this criticism was afforded in the measurement of μ the refractive index of a number of sols during coagulations. The curves in Fig. 1 show the course of μ-change

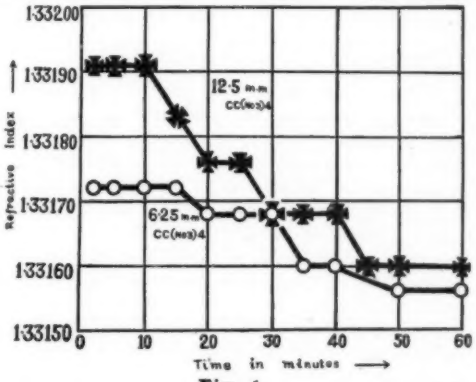

Fig. 1.

during two typical coagulations of the above sol by solutions of cerium nitrate. On general considerations it is seen that μ depends upon the total optical path for a given light beam passing through the colloid. This, in part, is constituted by the dispersed material. It is expected, therefore, that μ would alter due to micellar changes during

coagulation. The curves in Fig. 1 show in a striking manner the essential discontinuity characteristic of the course of the reaction, observed with a means markedly different from that employed previously.[1] This appears to be a general result at any rate in the *slow* region, as judged from data of over 80 cases examined in these Laboratories. Its prediction constitutes one of the chief criteria of the validity of any theory for both the kinetics and the mechanism of coagulation.

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[1] Joshi and Viswanath, *J. Indian Chem. Soc.*, 1933, **10**, 329; Joshi and Menon, *ibid*, 1933, **10**, 599; Joshi and Nanjappa, *ibid.*, 1934, **11**, 133; Joshi and Iyengar, *ibid.*, 1934, **11**, 555, 573; Joshi and Panikkar, *ibid.*, 1934, **11**, 797; also *Journ de. Chim. Phys.*, 1935, **32**, 455.
[2] *Z. Phys. Chem.*, 1917, **92**, 129.

The New Orienting Rule of Svirbely and Warner.

THE new empirical rule in aromatic substitution, recently enunciated by Svirbely and Warner[1] as generally applicable, connecting the electric moment of the benzene derivative and the directive power, is open to many objections.

Claiming that there were only three definite exceptions to the rule, *i.e.*, the cases of benzoic acid, methyl and ethyl benzoates for which moments less than 2·07 D have been recorded,[2] the authors, apparently to justify their rule, have revised the moments of the last two compounds to 2·43 and 2·52 respectively and have advocated a redetermination in the case of benzoic acid. Without digressing about the validity of the experimental method adopted in their revision, we point out that Bergmann and Weirmann[3] could, once more, only obtain the value of 1·91 for methylbenzoate and from what follows, it can be inferred that the rule is not based on grounds too solid to predict with certainty a moment greater than 2·07 D either for benzoic acid or for these esters.

Leaving aside the notorious case of the nitrosogroup, it is pointed out that benzoin,[4] deoxybenzoin,[5] and dibenzylketone,[6] which have been classified by the authors as *meta* directing in accordance with their rule because of their moments 3·4, 2·95 and 2·65 respectively, have actually been found to have the opposite effect! The failure of the rule in these cases is strictly in accordance with the expectation of the modern theories of aromatic substitution,[7] and is not to be attributed to any of the factors referred to by the authors. It can also be predicted safely that the rule is bound to fail in the cases of the substituents like $-CH_2.CH_2.CO.C_6H_5$, $-CH_2SO.C_6H_5$, $-CH_2.SO_2.C_6H_5$, $-CH_2.SO_2.CH_2.C_6H_5$, etc., all of which are expected to possess moments higher than 2·07 D but direct only to *ortho* and *para*.

Further, the following substituents have all been found to be *ortho* and *para* directing; but possess moments[8] greater than 2·07 D: CH : CH.CHO[9] (3·71); $-CH_2.CN$[10] (3·56); $-CH:CH.CO.CH_3$[11] (3·3); $-N(NO).C_6H_5$[12] (3·39); $-SCN$[13] (3·00).

The dipole moment of the molecule can be claimed to bear a direct relation, as suggested in the rule, to the directive capacity of the substituent only if, according to the Robinson-Ingold theory of aromatic substitution, it decides the electronic disposition, as governed by the general polar and tautomeric effects, of the bond between the nuclear carbon and the attached atom of the substituent group. But this is not the case always[14] particularly with complex substituent groups, where the rule has been shown to fail. If we consider the directive capacity of a *meta* directing group R with a high moment (*e.g.*, NO_2, CN, SO_2R') when attached to the ring through methylene groups (as in $-CH_2.R$, $-CH_2.CH_2.R$), we find that even by the intervention of one carbon atom between R and the ring, the substituent becomes *ortho* and *para* directive, though the moment remains but little altered. Thus it is clear that this "measurable property of the molecule," the dipole moment, can be connected with the directive power only with strict limitations.[15]

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January 11, 1936.

[1] *J. Am. Chem. Soc.*, 1935, **57**, 655.
[2] Table of Dipolements, *Trans. Farad. Soc.*, 1934, **30**, Appendix.
[3] *J. Am. Chem. Soc.*, 1935, **57**, 1755.
[4] Chattaway and Coulson, *J. Chem. Soc.*, 1928, 1081.
[5] Pictet, *Ber.*, 1886, **19**, 1064; List, B., *ibid.*, 1893, **26**, 2452; Golubew, *ibid.*, 1878, **11**, 1939.
[6] Manchot and Krische, *Ann.*, 1904, **337**, 176; Manchot and Zahn, *ibid.*, 1906, **345**, 331.
[7] Waters, *Chem. Rev.*, 1930, **7**, 409, 420.
[8] *Cf.* ref. 2 for the moments recorded.

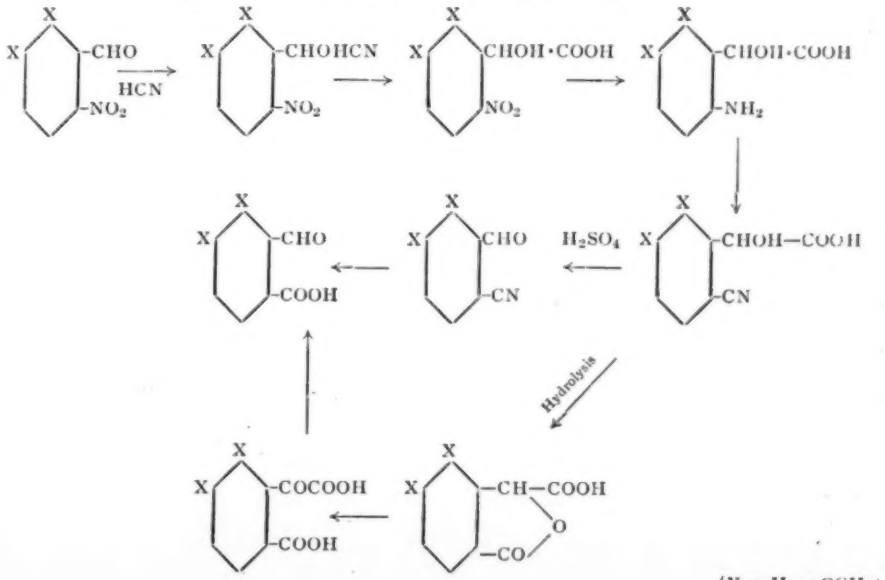
[9] Diehl and Einhorn, *Ber.*, 1885, **18**, 2336.
[10] Flürscheim and Holmes *J. Chem. Soc.*, 1928, 2330.
[11] Baeyer and Drewsen, *Ber.*, 1882, **15**, 2859; *ibid.*, 1883, **16**, 1954.
[12] Julliard, *Bull. Soc. Chim.*, (3) **33**, 1173.
[13] Challenger and Collins, *J. Chem. Soc.*, 1934, **125**, 1377.
[14] Robinson, *Soc. of Dyers and Colourists*, 1934, Jubilee Vol., p. 75; *cf.* Smith, *Trans. Farad. Soc.*, 1934, **30**, 754, 758.
[15] *Cf.* Sutton, *Proc. Roy. Soc.*, 1931, **133A**, 668.

A New General Method for the Synthesis of Substituted Phthalid-Carboxylic Acids.
(A Preliminary Note.)

In a recent paper, one of us critically examined the various methods available for the synthesis of substituted phthalide-carboxylic acids.[1] During the course of synthetical experiments on *o*-cyano-aldehydes, none of which have so far been synthesised, we have incidentally discovered a simple method of synthesising phthalide-carboxylic acids, which should be capable of wide extension. All attempts in the past to convert *o*-aminoaldehydes into *o*-cyano-aldehydes by the usual Sandmeyer's reaction have been unsuccessful.[2] Attempts to convert the Schiff's bases, acetals, and oximes of the corresponding *o*-aldehydo-amines into the corresponding cyano-compounds have, also, not been, so far, very successful.[3] It has been found, however, that *o*-amino-cinnamic acids, which could be readily obtained from the corresponding *o*-nitroaldehydes, can be smoothly converted into *o*-cyano-cinnamic acids, and the latter can be oxidized in poor yields to the corresponding *o*-cyano-aldehydes.[4] In view of the poor yield of the oxidation product, we next attempted the synthesis of *o*-cyano-aldehydes and *o*-carboxy-aldehydes in the manner shown below.

We have found that *o*-nitromandelic acid and substituted *o*-nitromandelic acids can be smoothly converted into the corresponding amino-mandelic acids through ferrous sulphate and barium hydroxide.[5] The sodium salt of the amino-mandelic acids were then diazotized under strictly defined conditions and converted into cyano-mandelic acids through the aid of Sandmeyer's reaction. The latter type of acids on hydrolysis gave the corresponding phthalide-carboxylic acids in fair yields.

This method of synthesis of the substituted phthalide-carboxylic acids should be of considerable interest as phthalide-carboxylic acids, *e.g.*, meconinecarboxylic acid, form the essential starting substance for the synthesis of the alkaloids of Berberine type by the method of Perkin, Ray and Robinson.[6] Moreover, the phthalide-carboxylic acids could be readily oxidized to the corresponding phthalonic acids, and the latter converted into the corresponding *o*-aldehydo-carboxylic acids.[7]



(X = H, or OCH_3)

The detailed account of these experiments would be published elsewhere.

S. K. CHAKRAVARTI.
P. R. VENKATARAMAN.

Annamalai University,
Annamalainagar,
January 6, 1936.

[1] Chakravarti and Swaminathan, *J. Annamalai University*, 1935, **4**, 44.

[2] Compare Rilliet and Kreitmann, *Helv. Chim. Acta.*, 1921. **4**, 596; Chakravarti, *J. Indian Chem. Soc.*, 1929, **6**, 208.

[3] Unpublished work, Chakravarti and K. Ganapati.

[4] Chakravarti and Ganapati, unpublished work. Compare also Chakravarti and Perkin, *J. C. S.*, 1929, 193; Chakravarti, *J. Indian Chem. Soc.*, 1929, **6**, 214.

[5] Compare also McKenzie and Stewart, *J. C. S.*, 1935, 104, whose paper was published whilst this work was in progress.

[6] Ray and Robinson, *J. C. S.*, 1925, **127**, 740; Chakravarti and Perkin, *J. C. S.*, 1929, 127; Chakravarti and Swaminathan, *loc. cit.*

[7] Fritsch, *Annalen*, 1897, **295**, 359; Chakravarti, *J. Indian Chem. Soc.*, 1933, 693; Chakravarti and Swaminathan, *J. Indian Chem. Soc.*, 1934, **715**, 873.

Influence of Weather and Prices on the Cotton Crop of the Bombay Presidency.

ONE of the aims of the Agricultural Meteorology Branch, Meteorological Office, Poona, is to investigate statistical relationships between weather and crops. The cotton crop was taken up to begin with and the analysis has been completed for the Bombay Presidency which occupies nearly four million acres, about one-fourth of the total cotton acreage in India.

Cotton Tracts of the Bombay Presidency.—The cotton belt of the Presidency, excluding Sind, can be divided into four distinct tracts defined by the character of soil and season and consequently also by the type of cotton grown in them though they naturally grade off into one another. These tracts are:

(i) The South Gujarat with 30″—40″ of annual rainfall.
(ii) Karnatak with 20″—30″ of annual rainfall.
(iii) North Gujarat with 25″—30″ of annual rainfall.
(iv) Deccan Tract with 20″—30″ of annual rainfall.

Sources of Data and their Limitations.—The figures of acreage, yield and price have been taken from the *Season and Crop Reports* of the Bombay Presidency and the meteorological data from the records of the India Meteorological Department. While the official statistics of area sown are fairly accurate, the data of yield per acre have certain limitations. The detailed examination in recent years of the official forecasts, the returns of cotton ginned and pressed, trade statistics, by the Indian Central Cotton Committee, has conclusively shown that the yield of cotton has in general been underestimated. It cannot be expected, therefore, that the statistical analysis of the "yield per acre" and weather factors would indicate anything more than certain general relationships.

Secular Changes and Variability.—The area and yield data for cotton of important districts of each of the above tracts have been examined. Some interesting results as regards the influence of weather on area and yield and also the effect of the prices of cotton on area sown have been obtained. Significant trends in the area, yield and prices have been noted in the data extending over a period of 43 years commencing from 1890. The mean acreage and its coefficient of variability are given for different districts in columns 2 and 3 of Table I below. It is interesting to observe that the area under cotton in Ahmednagar is very variable and seems to depend mostly on the timeliness of the early rains.

TABLE I.

District	Mean area sown (thousands of acres) 1890-1932	Coefficient of variability
Khandesh ..	1,229	8·2
Ahmednagar ..	116	54·5
Belgaum ..	206	23·1
Bijapur ..	500	30·0
Dharwar ..	567	12·9
Ahmedabad ..	328	29·2
Broach ..	269	14·9
Surat ..	134	15·5

Correlations of Area with Prices and Rainfall at the Time of Sowing.—Correlations of 'area' with 'prices and rainfall at the time of sowing' have been worked out for the above cotton-growing districts. Prices rather than rainfall seem to dominate the area sown to cotton in the Khandesh, Ahmedabad, Broach and Dharwar districts while in the Surat district both the

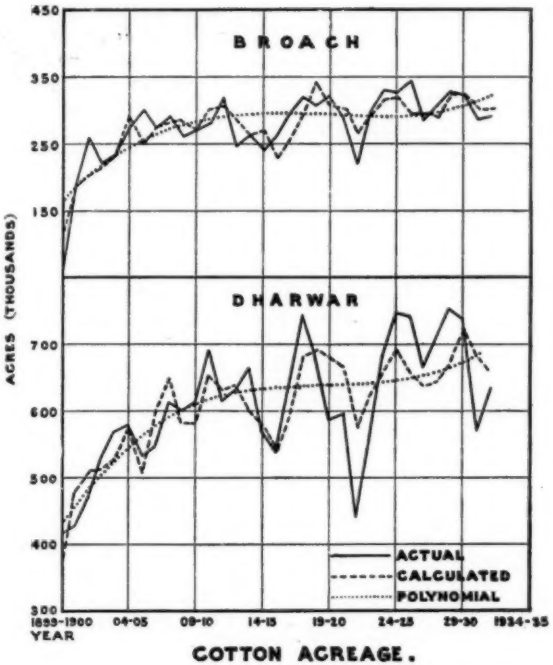


Fig. 1.

AREA.

Factors used.

(1) Broach District { Sowing—June, July. Harvesting—February, March.

June Rainfall and average price of Broach variety during the seven months January to July, prior to the sowing season.

(2) Dharwar District { Sowing—September. Harvesting—March, April.

September Rainfall and average price of Dharwar variety during the seven months January to July prior to sowing season.

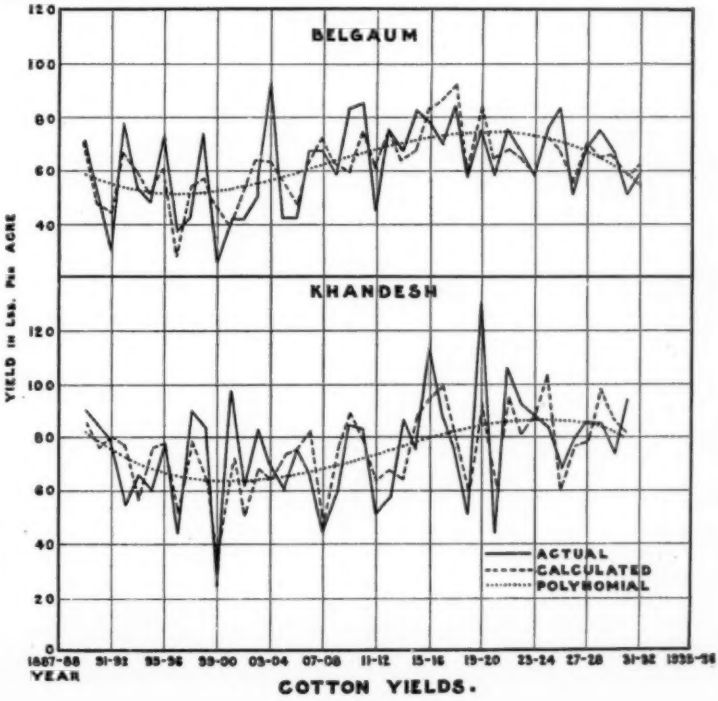


Fig. 2.

AREA.

Factors used.

(1) Belgaum District
Sowing—August, September.
Harvesting—February, April.

September and October Rainfall and October, November and December Maximum Temperatures.

(2) Khandesh District.
Sowing—June.
Harvesting—November, December.

July and September Rainfall and May, September, October and November Maximum Temperatures.

rainfall and prices show significant correlations. In the districts of Ahmednagar, Belgaum and Bijapur significant correlations between area and rainfall at the sowing time are obtained while those between area and prices are insignificant. Formulæ have been worked out for calculating the cotton acreage from prices and rainfall at the time of sowing. Fig. 1 shows the actual and calculated acreages in the Broach and Dharwar districts for a period of 33 years.

Influence of Rainfall and Maximum Temperature on the Yield of Cotton.—The limitations of the yield statistics have already been referred to. Use has been made of the past data as available for studying the influence of weather factors on the yield of cotton. Significant correlations of rainfall and maximum temperature with cotton yields have been obtained for the cotton-growing districts. The actual and the calculated values for Belgaum and Khandesh are given in Fig. 2. The results will be discussed in greater detail elsewhere.

Investigations on other crops will be taken up.

R. J. KALAMKAR.

Agricultural Meteorology Branch,
Meteorological Office,
Poona,
December 11, 1935.

Cell Sap Acidity and the Incidence of White-Fly (*Bemesia gossypiperda*) on Cottons.

THE relationship between plant "condition" and insect attack is of considerable significance in crop production and crop improvement. Insects often show a preference for certain parts of their host or for certain of their hosts during particular seasons. The White-fly of cotton provides an excellent illustration of this phenomenon. It invariably lays most of its eggs on tender leaves on which, consequently, the nymphs feed. It shows partiality for different varieties of cotton, at different times. Early in the season, the indigenous varieties are more seriously infested but the relative infestation changes over from the indigenous to American types during July or August.

This behaviour most probably is mainly dependent upon some constitutional difference in the cell sap of the tender and "old" leaves of the host plants and changes in the chemical composition in the varieties during different parts of the year. Since the one easily measurable change in the sap is its reaction or pH value, investigations were undertaken during 1932 and 1933, to test this in the case of Mollisoni (indigenous) and 289 F. (exotic) types grown under identical conditions. To start with, the observations were made with the glass electrode which was later on replaced by the micro-antimony electrode devised by one of us (Puri).

Preliminary results have shown that the pH gradient from top to bottom varied with the age of the plants. Differences were not marked in the very early stage in growth but later on the pH increased as we proceeded from top to bottom. Towards maturity, however, these variations became erratic and the middle portion showed the highest pH. A mean of the pH values of all the leaves, therefore, was taken for comparative purposes. These gradients in pH have also been noted by other investigators. Gustafson[1] (1924) found higher pH in the upper leaves of Sunflower; Mukerji[2] (1928), on the other hand, found a lower pH in the uppermost leaves of *Mercurialis perennis*, and Haas[3] (1920) noted a higher pH in upper 3 inches of shoot in sweet clover.

The present investigation has shown, that, during 1932 pH values for 289 F. were, on an average, slightly lower than those of Mollisoni, till the end of June or beginning of July, then they equalised and were practically uniform till August after which Mollisoni again showed higher pH values. The relative incidence of White-fly attack corresponded with the trend of the pH curve indicating partiality towards higher pH values and, therefore, was suggestive of some correlation with the reaction in the plant juice. The infestation, however, was not affected immediately but there was noticed a certain amount of lag. The nymphs being fixed on the leaves naturally could not move, and moreover, it must take some time before the effect of the change in the pH values is felt by the insects feeding on the sap. During 1933, the White-fly attack in general was quite insignificant and the pH values were also relatively low.

A thorough investigation along these lines may show that the variation in pH might be responsible for immunity of varieties of plants and control seasonal outbursts of certain pests. If so, there will be abundant possibilities of preventing attack of sucking

insects by controlling the pH values of the cell sap through soil treatment, or evolution of varieties with pH outside the taste of an insect. The attention of workers in general agriculture, plant breeders, soil physicists, chemists and mycologists is drawn to this line of research.

M. AFZAL HUSAIN.
A. N. PURI.
K. N. TREHAN.

Agricultural College,
Lyallpur, Punjab,
November 20, 1935.

[1] Gustafson, F. G., *Amer. Jour. Bot.*, 1924, **11**, 1-6.

[2] Mukerji, S. K., *Proc. Linn. Soc.*, 1928, **140**, 3-5.

[3] Haas, A. R. C., *Soil Science*, 1920, **9**, 341.

Some Abnormalities of the African Pearl Millet.

RECENTLY through the propaganda made by Kunwar Sursinhaji, Director of Agriculture, Jamanagar State, Kathiawad, an African variety of *Pennisetum typhoides*, Stapf and Hubbard, *viz.*, the "Jamanagar Giant" producing an ear-head of six feet length was distributed and grown under experimental conditions in several parts of the Baroda State. Under local conditions the crop on the Baroda Agricultural Experimental Station and the surroundings was not able to produce the grain in spite of the profuse tillering—the factor of pollination being more or less interfered with. The "Jamanagar Giant" ear-heads resemble closely those figured by Rangaswami Ayyangar *et al*[1] and produce the same atavistic abnormal branching extending to an area up to six inches from the base.

Very often this basal branching was accompanied with the total bending of the ear-head (Fig. 1—1). Apical twining of the ear-head is represented in Fig. 1—2 and this twining is often associated with the bifid character of the ear (Fig. 1—3). Contortions, intricately interwoven, have been very common and the complicity may be witnessed from Figs. 1—4, 5, 6. Splitting or branching of the ear-heads which one comes across in local Bajri (Figs. 2—2, 3, 4) is also met with in "Jamanagar Giant" (Fig. 2-1) giving almost the form of fingers to the ear-head. Very typical basal branching along with leaf production is represented in number 5 of Fig. 2.

Branches from nodes on the same tiller were usual and two plants producing this branching with very simple and small types of ear-heads (Fig. 1—7) have been observed.

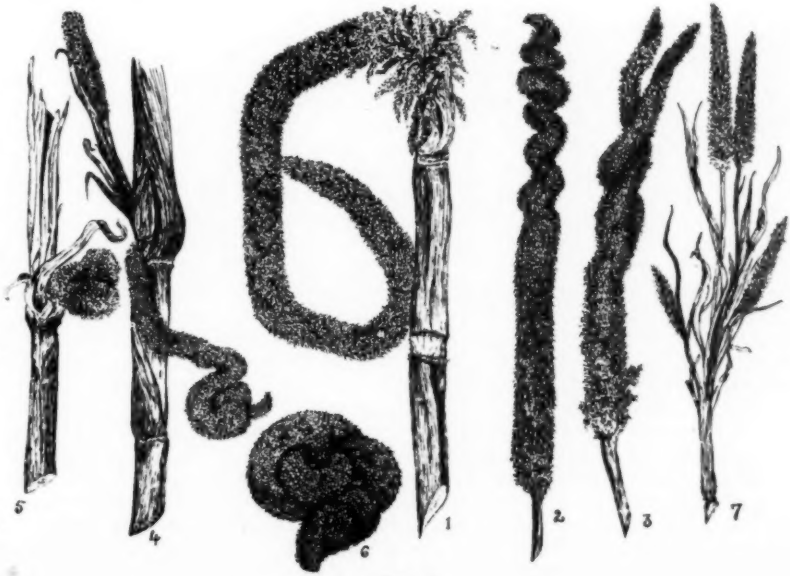


Fig. 1,

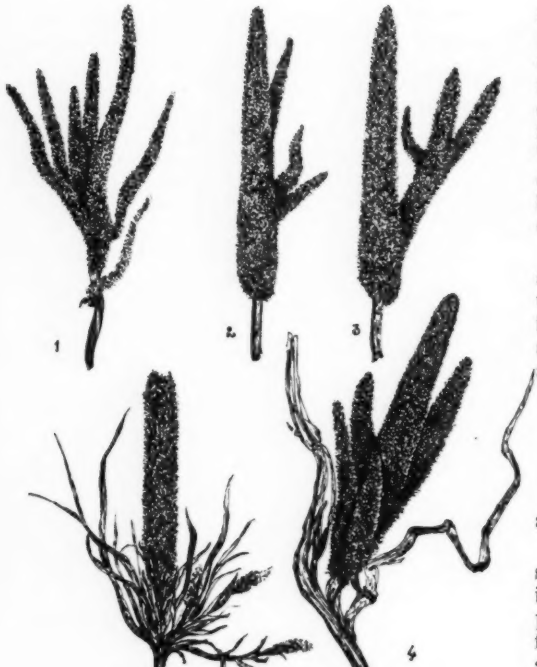


Fig. 2.

A few seeds from the latter are collected for further observations.

V. N. LIKHITE.
R. S. PATIL.

Research Laboratory,
Agricultural Experiment Station,
Baroda,
November 29, 1935.

[1] *Curr. Sci.*, 1935, **4**, 237-238.

Mortality of Fish of the Madras Coast in June 1935.

LARGE catches of fish, more or less in an exhausted condition, were made by the fishermen, on the Madras coast, in the month of June 1935. Numerous anemones, Cavernularias, Sipunculids, and countless Tetrodons and Diodons in various stages of growth were washed ashore. The papers reported that the sea-water was unusually muddy. Enquiry amongst the fishermen revealed the fact that the fish near the coast showed a tendency to swim near the surface, allowing of easy capture. Townet water collected at this time was almost of a soupy nature on account of the countless millions of *Noctiluca miliaris* present in the water, imparting a pink hue to the surface waters. The plankton showed also a large number of dead fish fry mostly belonging to the Scienidæ. Such fish mortality has been observed in previous years as well.

It is well known that there is a certain amount of variation in the temperature and the salinity of the coastal waters of Madras in the different parts of the year, and according to Sewell's charts,[1] the following are the figures for salinity per mille :—

September—November	.. 30·00 to 32·00
December—February	.. 33·25 to 33·50
March—May	.. 33·50 to 33·50
June—August	.. 34·00 to 34·50

The temperature of the sea-water and the air above is highest during May to June.

The amount of oxygen dissolved in the sea-water is known to be affected by changes in temperature and salinity.[2] It seems probable that the exhausted condition followed by the death of several marine animals, especially of the fish near the coast, during summer, is due to oxygen deficiency caused by the increase of temperature and salinity, heightened by the greater demand for oxygen by the animals owing to the higher rate of metabolism consequent on higher temperature. Further, the fall in the Diatom activity in the Madras coast about this period,[3] followed by an enormous increase of the Dinoflagellates, soon tends to use up the available oxygen, as a result of which many organisms suffer and get asphyxiated.[4] As the surface waters contain more of dissolved air, there is a tendency on the part of fish to come to the surface, with fatal results as their gills probably get choked up by the swarming Dinoflagellates. A similar observation of Dinoflagellates causing mortality of fish and other marine animals, has been recorded for the Calicut coast in September 1922, by Hornell and Ramaswami Naidu.[5] The sea current which at this time is towards the head of the Bay is probably another contributory cause, and many bottom forms get loosened and float up to the surface. Large numbers of bottom inhabiting Sipunculids were found floating, and this could be accounted for only by some such explanation as the one given above.

The mortality of the fish fry in particular is very considerable, and this is due to the fact that they are more easily affected by adverse conditions than grown-up fish. Wells[6] has conclusively shown for *Fundulus* that the increased oxygen requirements at higher temperatures are much greater for young fish than for adult forms.

R. GOPALA AIYAR.

University Zoological
Research Laboratory,
Madras.

[1] Sewell, R. B. S., *Mem. As. Soc. Bengal*, 1929, **9**.
[2] Murray and Hjort, *Depths of the Ocean*, 1912.
[3] Menon, K. S., *Rec. Ind. Mus. Calcutta*, 1931.
[4] Mayer, *Carn. Inst. Washington*, Publ. 183, 1914.
[5] Hornell, J., and Ramaswami Naidu, M., *Madras Fisheries Bull.*, 1923, **17**.
[6] Wells, N. M., *Physiol. Zool.*, 1935.

Ancient Wheat and its Viability.

ON every occasion when any fresh archæological discovery is made, the votaries of ancient civilization lose no time for the glorification of achievements of the past. In some cases, praise is well deserved and based on substantial evidence, but in other cases much fantastic colour is given to the value of findings and ridiculous pretensions are made. One such instance that has come to the forefront, time and again, is that of the germination of Egyptian mummy wheat and recently of the wheat found in the excavations carried out at Mohenjodaro. In spite of conclusive evidence a great many people still believe that the ancient wheat of Egypt over 6,000 years old has been found to be capable of germination. In this connection, Bower[1] (1923) mentions that "A. de Candolle, after examining the evidence upto 1882, concluded that no grain taken from an ancient Egyptian Sarcophagus and sown by horticulturists has ever been known to germinate, nor is there any trustworthy evidence upto the present date." Buller[2] (1919) states that "It is still currently reported that this mummy wheat, after being sown, has been observed to germinate; but there is no truth whatever in this story. Careful experiment has demonstrated that all real mummy wheat has entirely lost its vitality."

The writer[3] had an opportunity to report as follows on the examination of some samples of cereals found at Mohenjodaro and kindly supplied by Rai Bahadur Daya Ram Sahni, Director-General of Archæology in India :—

General.—The grains in all the three samples are completely carbonised. They have turned black both on the surface as well as inside and have the appearance of charred material. The surface is quite smooth as in fresh normal grains and both the proximal and distal ends are intact. The form and outline of the grain is very well preserved and they still possess their typical shape.

The embryo retains its form in some grains but in others it is disintegrated and a hollow is left.

The grains were tested for germination power but were not found to be viable at all. On being moistened with water the grains crumbled into powder forming fine black ash.

Sections of the grains did not show any cells.

Sample No. I.—L. 855 Room No. 11, 2 ft. B.S.L.

This is a sample of wheat grains and consists of two types, namely, (i) *Triticum sativum*, sub sp. vulgare (common wheat), and (ii) *Triticum sativum*, sub sp. compactum (Dwarf wheat). There is a greater proportion of the first type.

Measurements of the grains of the sample as compared with those of the present-day corresponding cultivated wheats are as follows :—

Length of grain vulgare type, present-day cultivated ..	0·57 cm.
Length of grain vulgare type, excavated sample	0·55 cm.
Length of compactum type, present-day cultivated	0·47 cm.
Length of compactum type, excavated sample	0·43 cm.

Sample II.—D. K. 10478 Room No. 0190, and

Sample III.—D. K. 11419 Room No. 0208–7·11 B.S.

Both these samples are of barley of the naked (huskless) variety *Hordeum vulgare* Linn., variety nudum. There appear to be two kinds of grain, one longer and narrower than the other.

Remarks.—Barley is stated to be one of the first cereals cultivated by man. Grains of barley have been discovered in Egypt belonging to pre-dynastic and early dynastic periods.

These samples are believed to have remained buried for about 4,000 years and are of later date than the Egyptian mummy wheat. In face of this evidence and the opinion of other authorities, stories about the ability of ancient wheats to germinate have to be received with caution. All

speculations about such old wheats being viable should be set at rest. In the course of some work that the writer has done on the duration of life of wheat, it has been clearly established that wheat grains when stored with usual precautions against the attack of insects lose germination power totally within 8–10 years.

JAI CHAND LUTHRA.

Agricultural College and
Research Institute,
Lyallpur,
December 9, 1935.

[1] Bower, F. O., "Botany of the Living Plant," 1923 Edition.
[2] Buller, A. H. R., "Essays on Wheat," 1919.
[3] Marshall, Sir John, "Mohenjodaro and the Indus Civilization," Vols. I & II.

A Biblio-Film Service.

THE direct result of the rise in prices of German periodicals and the imposition of an export duty on them by the Reich Government was the stoppage, by a majority of American libraries, from purchasing many of the German journals. In order to help scientific institutions in having access to these publications, however, the U. S. Department of Agriculture established in 1934 a laboratory for copying and distributing scientific papers and books on cine-films. Even though the price of German publications has now been reduced, the U. S. D. A. Biblio-Film Service seems to have become a permanent institution; for, a keen demand for other rare publications

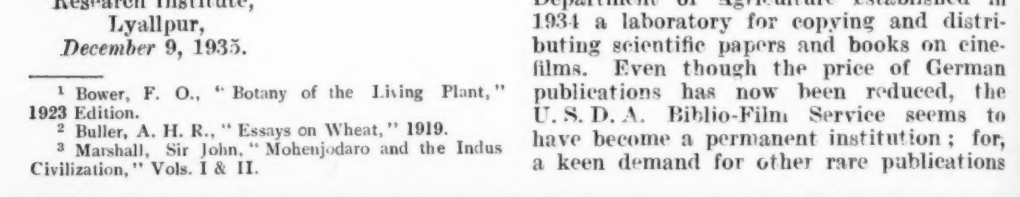


Fig. 1.

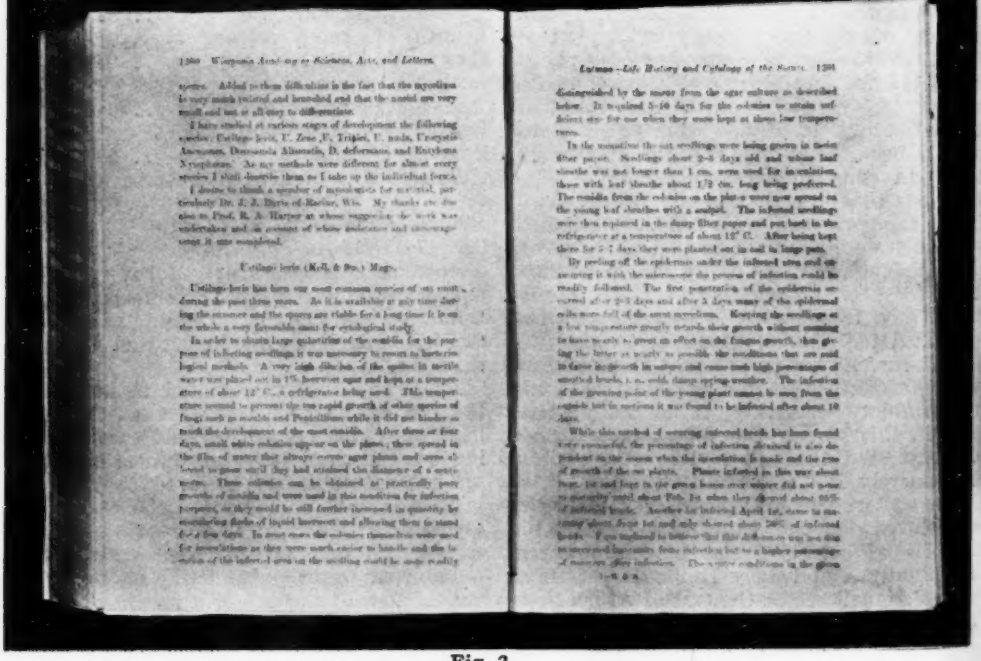


Fig. 2.

which can be easily obtained in this manner at a relatively small cost seem to have now arisen.

Recently the writer wished to consult a paper published in a rather rare journal. No reprint being available, a request was sent to the U. S. A. which brought a cine-film strip containing negatives of each of the 46 pages of the article at a cost of 35 cents (about a rupee). This strip can be inserted in a projector and read or prints can be made and read with a lens of low magnification. Enlargements can also be made which permit direct reading. Fig. 1 illustrates a print made from the film and Fig. 2 an enlargement, both made at Pusa.

B. B. MUNDKUR.

Imperial Institute of
Agricultural Research,
Pusa, Bihar,
January 6, 1936.

The Total Eclipse of the Moon.

THERE was a total eclipse of the Moon on the 8th January 1936. The circumstances of the eclipse was published, in advance, in the *Government Gazette*, dated the 24th December 1935. The phenomenon was observed at the Trivandrum Observatory and photographs taken at different intervals. The commencement of the eclipse was observed to be at 9–36 P.M., and the totality began at 11–6 P.M. The duration of the totality was about 24 minutes and that between the first and the last contact of umbra was about 3 hrs. 22 minutes. As the sky was very clear, the phenomenon could be observed conveniently throughout. Just before the commencement of the totality, the occultation of the star δ Gemini was also observed

Fig. 2. 10 p. m.—Jan. 8th.

Fig. 1. Full Moon, 9 p.m.—Jan. 8th.

Fig. 3. 0-35 a.m.—Jan. 9th.

through the telescope. During the time of totality the southern side of the Moon's disc was much brighter than the northern side, as the Moon passed through the southern half of the Earth's shadow.

H. SUBRAMANI AIYAR.

H. H. The Maharaja's Observatory,
Trivandrum,
January 11, 1936.

Energy and Economics.

IN *Current Science*, May 1935, appeared a valuable paper entitled "Energy and Economics" by Dr. Gilbert Fowler.

This comprehensive article deals with the fundamentals underlying production, *e.g.*, man-power, solar energy and other natural forces which have been harnessed for man's service. Dr. Fowler suggests a new unit he calls "the Ern" which might be employed as a universal unit measure for production. The Ern is based on the 10 gms. of Nitrogen (300 calories) which is required in the daily food ration of a man.

This paper because of its scientific approach to economics is unusual, and it appropriately appears in *Current Science*. Its publication perhaps indicates prophetic vision on the part of the Editorial Board for it is becoming apparent that production and distribution are essentially technical and scientific matters, and that any nation which produces goods has evolved immediately all the credit necessary to purchase and consume those goods. This is irrespective of any antiquated notion that the artificial financial system has the right to come forward and inform a state which has already produced the goods, that they must not or cannot eat or use those goods produced.

The time has long past when the scientists —*no matter of what calibre*— can afford to assert he has no time for economics. Economics and finance have never been a science and that is why they fail to handle the scientific facts of our modern stupendous production and the present age of plenty which applied science has evolved. Prof. Einstein on reaching New York some 2 years ago publicly announced there that "the production is available, it is merely a matter of arranging distribution". Prof. Soddy of Oxford has for many years ("Man *versus* Money," etc.) bitterly inveigled against a financial system which stultifies so outrageously the distribution of goods following the ever-increasing output rendered possible now by scientific research.

While it is obvious every one should concentrate upon his work, it is equally obvious every one should grasp at least the basic principles of finance, production and distribution or he will find he again has no work or reduced pay because of this common delusion that you can leave distribution to interested financiers. Adequate distribution is essentially *everybody's* job, especially every voter's job, or the distribution will not be carried out. There is a kind of wooden-headed conceit extant among science research men which also leads fine business men and primary and secondary producers to feel proud that they "wisely" leave finance and distribution to others—and then they wonder why the markets fail and salaries fall and bankruptcies occur. It is just this stupid attitude, encouraged by a well-controlled press, which international financiers, industrial monopolists and munition manufacturers rely upon, and it is responsible for the present internal and international strictures.

There is now a widespread appreciation by intelligent and unprejudiced people in Europe, America and Australia—that it is not production in this age of plenty, but the antiquated financial system which fails to liberate the purchasing power for consumption of this enormous production, which is responsible for the past five years of world crisis. Nowhere is this appreciation more apparent than in England, Canada, Australia and New Zealand. The United States of America has failed by deliberately going into further debt and its methods are therefore doomed to failure.

In May this year the British Science Guild (6, John St., London, W. C. 2) published a Shilling pamphlet which outlines clearly some twenty schemes put forward in England to remedy the present intolerable position, and this publication has already been mentioned in an Editorial Note in *Current Science*, p. 214, October 1935. Reading these various proposals, if one may venture opinions, the McMillan and Prof. Keynes Schemes are very orthodox and unpromising; the Basil Blackett and especially Prof. Soddy's proposals are distinct steps forward; the Douglas Social Credit proposals are more fundamental and give greater promise of prosperity and security, while the communist schemes are more vague and hardly immediately possible.

It is significant that Alberta in Canada has a Social Credit Party in power in

Parliament and proposes to test some Social Credit methods. It is to be hoped their attempt will not be frustrated by adverse pressure of financial interests at Ottawa and elsewhere. Douglas Social Credit proposals have the advantage that they can readily be constitutionally adopted by a single nation, they provide purchasing power without increased debt or inflation, automatically introduce just prices at ample profit and yet leave private enterprise and initiative still able to reap success and further profits. The scheme paves the way to increased production and consumption, gradually eliminates taxation, gives security to business men and primary producers against bankruptcy: everybody's savings are safeguarded and employment and security against poverty are secured. As I write this letter news comes that the recently elected New Zealand Parliament is pledged to introduce Douglas Social Credit methods.

In conclusion may I refer again to Dr. Fowler's stimulating paper? While agreeing with the value of a universal unit measure of production "the Ern," this is, in my opinion, perfectly valueless and with no prospect of application until the readjustment of the present financial system, that is, until finance has been brought into accord with the physical facts of modern production by constitutional parliamentary measures involving no hiatus in either primary or secondary industry.

W. B. GURNEY.

Department of Agriculture,
Sydney, N.S.W., Australia,
December 22, 1935.

Blood Groups of the Pre-Dravidians of the Wynad Plateau.

By A. Aiyappan, M.A., F.R.A.I.
(*Government Museum, Madras.*)

KAPPERS[1] and PARR[2] in their recent studies of the races of the Near East have demonstrated that "blood-typing data on an area controlled by anthropometric measurements give evidence that the blood-typing approach to the study of anthropology has value". The jungle tribes of South India have been known for a long time to be the representatives of an extremely primitive strain of *Homo sapiens*, closely allied to the Veddahs of Ceylon and to the aboriginals of Australia.[3] Recent investigations have shown that the strain represented in a comparatively pure condition by the jungle tribes is not a mere survival in racial cul-de-sacs, but also permeates the lower castes of the general populations of the plains.[4] The problems in view, therefore, in the present investigation were: (*i*) whether serological tests would support and supplement the physical anthropologists' findings regarding the affinity of the hill-tribes of South India with Australians and (*ii*) what serological relationship exists between the higher Hindu castes and the hill-tribes.

Pre-Dravidian, Veddoid and Nishadic have been used by various investigators as synonymous terms to describe the tribes and the racial strain referred to above. Since the first of these terms has gained great currency and is, in fact, the oldest in use, it is advisable to retain it in conformity with the usual biological convention in nomenclature.

Physically the Pre-Dravidians are a good example of an extremely generalised race. As in the Veddahs the infantile nature of the face strikes the attention of the observer first. The face is round with prominent cheek bones, broad nose, retreating chin, and exceedingly sparse facial hair in the males. Short in stature, they have a proportionately longer torso. A moderate degree of prognathism was present in about 79% of the sample taken of the Paniyans of Wynad—the tribe selected for investigation.

This tribe was selected as the starting point of the present study because they are more isolated and in a purer state than most other Pre-Dravidian tribes. Wynad is a bastion like highland thrust sea-ward by the Deccan plateau into Malabar from the plains of which it rises abruptly to a height of about three thousand feet. A thick belt of moist evergreen forest fences it off from Malabar and a thick zone of malaria-ridden bamboo jungle from Mysore. People from the plains have

[1] Kappers, C. U. Ariens, "Contributions to the anthropology of the Near East," 1930, Amsterdam.
[2] Parr, L. W., *American Journ. of Phys. Anth.*, 1931, 16, 16.
[3] Haddon, A. C., "Races of Man," 1924, Cambridge.
[4] Guha, B. S., "Indian Census Report," 1935, 1, part III-A.

been penetrating slowly into Wynad from the twelfth century A.D. onwards,[5] but they have not yet made a success of the venture numerically or biologically. Any large scale admixture with the Paniyans has not taken place because of the great sexual jealousy of the tribal code, the poor stamina of the penetrating people and their fear of and dependence on the Paniyan labour force which is extremely unmanageable. Until recently the Paniyans were a very wild people not hesitating to murder a man from the plains for the sake of a piece of white cotton cloth. Not long ago they were living in caves and rock shelters as some members of the tribe do even now in the deeper regions of the jungles. According to the recent census, they number in all 32,410 in the Wynad and adjoining taluks of Malabar.

It has to be pointed out at this stage that the Australians, Veddahs and Paniyans, in spite of the general resemblances that they bear to one another, are differentiated by several anatomical characteristics, especially of the face. The aboriginal Australian has none of the infantile features of the Paniyan and has a greater stature than either the Paniyan or the Veddah. The Australian is hairier than the two latter. The Paniyan is prognathous while the Veddah is orthognathous, the former has his superciliary ridges less prominent than the Veddah and the Australian. The Australian is more variable in skin colour than the Veddah and Paniyan who range about 27 of Von Luschan's scale.

We know nothing of the blood-typing of the Veddahs, so we have to leave them out in the following discussion of the serological affinities of the Australians and Pre-Dravidians.

Two hundred and fifty Paniyans belonging to three different settlements were "typed" by the open slide method using two or three drops of blood. The standard serum was supplied by the Haffkine Institute, Bombay, through Prof. Ruggles Gates, F.R.S., under whose direction this work was done.

The following are the data obtained :—

Percentages in groups				Race Index	Frequencies		
O	A	B	AB		p	q	r
20·00	60·40	7·60	10·00	4·11	4·68	0·85	4·47

[5] Richards, F. J., *Indian Antiquary*, 1932, **61**, 170-174, 195-197.

The Australian has O 57%, A 38·5%, B 3·0 %, AB 1·5% and a racial index 8·8.[6] Comparison with the data for the Australians shows that the Paniyans bear no close resemblance to them, but both agree in having an extremely small percentage of B group. Von Eickstedt made an interesting suggestion that the Pre-Dravidians may be regarded as the Palæ-Europid type, a suggestion which the blood-group data support.[7] In a correlation table of the values of p and q for various races the Paniyans will be placed very near the Lapps and other peoples of Western Europe. The Paniyans differ from the Australians in having a much lower percentage of O (20 against 57 of the latter) which, according to the hypothesis of Snyder, is the most primitive group, A and B having arisen as subsequent mutations. Typing, however, a sample of 84 Central Australian natives Cleland found 38.1% O, and 61.9% A[8]. If further research confirms that bigger series than that tested by Cleland have also a similarly high percentage of A, then we shall be able to say that in spite of minor differences in physical characters, serologically the Paniyans and the Central Australians are closely linked.

Blood-group data support physical anthropology in distinguishing the Pre-Dravidians from the higher caste Hindus. The Mahrattas of Goa in the neighbourhood of the main Pre-Dravidian region are 29.25% O, 26.75% A, 34% B, and 10% AB.[9] They are, like the rest of the Hindus, typed, high in B. It may be possible that the non-tribal Hindu population is a mixture of the Pre-Dravidian with the very high percentage of A and another racial strain high in B. The 7·6% B in the Paniyans may have been introduced through miscegenation with the men of the plains which though of an imperceptible kind has been going on since the importation of large numbers of estate coolies from the plains.

[6] Ottenberg, R., *Nat. Hist.*, 1926, **26**, 80-84.

[7] Eickstedt Baron von, "Mysore Tribes and Castes," 1934, **1**, Bangalore.

[8] Gates, R. R., *J. R. Anth. Inst.*, **64**, 23-44.

[9] Correia, Lt.-Col. A. C. G. da S., "Les groupes-sanguins des Mahrattes de l'Inde Portugaise." Congrès International des sciences Anthropologiques et Ethnologiques. *Compte-rendu de la première Session, Londres*, 1934, pp. 86 87.

CONTENTS.

Presidential Address.

The Role of Science in the Recent Progress of Medicine.

By Sir U. N. Brahmachari, Kt., M.A., M.D., Ph.D., F.S.M.F., F.A.S.B.

IN the fitness of things the Indian Science Congress has been invited to hold one of its sessions in this historic place, thanks to the hospitality of its most enlightened ruler, His Highness Maharajadhiraj Raj Rajeshwar Sawai Shree Yeshwant Rao Holkar Bahadur, Maharaja of Indore. In the annals of Indian history, the Holkars hold an honoured place for their achievements in the field of arms and of peace.

In rising to address you at this annual meeting of your Congress, I feel I am hardly worthy to occupy an office which is associated with the names of those with whom I cannot compete in greatness. A few years ago, Lord Rutherford stated at a meeting of medical men that the hopes of the world rested upon their success and ever-growing usefulness. Aviation, wireless, and television have now been accomplished, but one thing still left to wish for, Lord Rutherford very truly remarked, was long life and health, and it was the medical profession with whom it lay to give that guerdon to humanity. For "Happiness lies, first of all, in health".

BIOCHEMISTRY.

As a matter of the most vital concern in nation-building, the problem of nutrition demands very careful consideration by statesmen and scientists alike, more so due to the fact, as has been recently observed, that a great part of the world's population is not consuming the necessary foodstuff. An eminent Swiss authority predicts the decay of civilization unless there is a fundamental revision of the people's diet.

It has been stated that the function of nutrition is probably the centre of medicine from a medical point of view, and that the proper dietary of man is a most important subject for the maintenance of health and prevention of disease. As has been observed by Hopkins, during the whole history the needs of nutrition and the kind and amount of food geographically available have played a great part in determining the destinies of races. It has been stated "tell me what you eat and I shall tell you what you are". "Man's place in future history will depend in no small degree on

the food he eats." Nutrition is one of the essential functions of life and its value cannot be too much emphasised.

Up to 20 years ago, the reign of calories was supreme in the field of nutrition, and it was held that if the proper amount of energy required for maintaining nutritional equilibrium could be worked out in terms of calories, then the last word would be said about the problem of nutrition. But it has now come to be recognised that certain substances that had eluded detection in the past, are indispensable in our dietary for the normal activity of the tissue cells and the prevention of certain diseased conditions. Further, the study of the problem of nutrition has increased in recent times from the quantitative to the qualitative standpoint, especially with respect to the proteins.

Though it was long known that diseases like beri-beri were due to deficiency in the food of certain substances of unknown chemical nature, it was Hopkins who made in 1912 the monumental discovery of the value of the "accessory food factors", or the "vitamines" as they were termed by Casimir Funk, in the maintenance of normal functional activity and growth. The progress of research upon the nature, distribution and functions of vitamins has been very intense in recent days. To attempt to summarise all that is known about them is beyond the limits of my lecture. The discovery of vitamins has led to the relief of a considerable amount of suffering and disablement that is particularly true in regard to rickets. Many of them are simple chemical substances and it is possible that each of them possesses a strict specificity in its action, though lack of more than one vitamin may be responsible for the causation of the complex phenomena manifested by disease.

The function of vitamins and the pathological lesions due to their deficiency are known to those among you, who are biochemists or who belong to the medical profession. I shall not discuss them here.

It is possible that the lack of vitamins does not play such an important part in the causation of disease as has been claimed by some observers and that the symptoms following a deficiency of certain vitamins may be attributed to a disturbance in the gastro-intestinal canal. It is realised to-day that the processes of digestion are much more complex than was hitherto thought. The secretion of the intrinsic factor is but a case in point. It is now known that vitamin B_1 deficiency is the cause of lack of appetite and defective movements in the alimentary canal. It requires but little imagination to conceive that these effects must have some fundamental cause and that they could lead to a number of abnormal sequelæ, such as, defective absorption, stasis and toxæmia, to mention a few.

The minimum amount of protein required for the dietary of man has been a matter of dispute for a long time. Originally found by Voit at 119 grms., it was afterwards raised by Atwater to 125 and subsequently lowered by Chittenden to 60. Sherman quotes it at about 44·4. It has now been recognised that the quest for a protein minimum is really an illusion, as it depends not on the quantity but on the kind of protein supplied. The work of Hopkins on the essential amino-acids in connection with nutrition has come into prominence in the present day. As has been pointed out by him, the food proteins which can be used with the greatest economy in the body are those which contain all the amino-acids in such relative proportions as will correspond most nearly with their proportion in the living tissues of the consumer. These are the proteins of so-called high biological value, constituting "the first class proteins". It has been observed that the average consumption of Cambridge under-graduates, those in training being excepted, is about 80 grms. of protein.

There are many problems that await fuller investigation by physiologists and biochemists in future before the perfect diet can be proclaimed. A food in order to be effective, must be ingested by a body both physically and psychically sound. It is possible to be well-nourished on the simplest of dietaries. Who can say for certain what is the optimum protein diet or the optimum intake of fat? What about the food of the Eskimos, the human carnivores of the world, who live for long periods on purely animal food? Hindhede has emphasized the superiority of the high fat, low protein diet of the Danish farmers over the high protein, low fat diet of the neighbouring Finlanders. But is this applicable to all mankind? There has been much talk about the energy value of different foods expressed in calories. But, as Cathcart has said, are not these

merely convenient units of measurement? How are we to explain the deleterious effects of "very high" cereal dietary and how are they corrected by "protective" foods, such as milk and leafy vegetables? Do the cereals contain any toxins, which are neutralised by a proportional quantity of the protective food? What definite information is available as to the body needs of the different kinds of vitamins? A further question is the problem of hypervitaminosis, as also the actual part played by vitamins, and any difference which may arise from taking synthetic or natural vitamins.

Nearly 90 years ago, Chevers taught that the dietary of the Hindus with a very moderate quantity of animal food was the fittest for a tropical climate. Thus he wrote, "It is certain, that the law-givers, who prescribed for the people of India a diet consisting mainly of vegetables and water, the lighter kinds of animal food, such as fish, pigeons and goat's flesh, being only occasionally introduced in moderate quantities, judged almost as physiologically as they could have done, had they studied at the feet of Liebig and Prout." Similarly in a discussion on the dietary of man, the meatless diet of some of the finest soldiers of His Majesty's Indian Army who fought in the last great World War was highly extolled. This is an interesting subject for research in the quest of minimum animal protein required for human consumption and the future may show that it may be influenced by climatic conditions. Recent researches of Berg tend to show that apart from the nature of proteins, there are other factors which determine the minimum quantity of protein necessary to preserve nitrogenous equilibrium, such as, the particular protein the subject is accustomed to taking and the ratio of inorganic bases to inorganic acids available to, or formed in the body of, the subject.

This brings me to the question of animal *versus* vegetable protein. Investigators of the present day hold that, in general, proteins of animal origin are superior to the vegetable proteins for the purposes of nutrition and that the testimony of human vegetarians is useless in determining the amount of animal protein requirement of man, because they were probably not vegetarians during the first part of their lives.

Are there first class fats? At present we know little about the nutritional value of different fats, but some work goes to show that certain fatty acids of the linoleinic series may be essential. It has been stated that the synthetic fat intarvin may be used by fasting persons of normal health without the development of acidosis. Do not these adumbrate the possibility of the existence of first class fats? Further work is also necessary to determine if there are essential carbohydrates.

In recent years there has been an advance in our knowledge of the importance of inorganic substances, especially minerals in our dietary. Many of these such as calcium and phosphorus are required for structural purposes and their deficiency gives rise to structural diseases. There are others which are required to be present in minute quantities in our dietary and which are perhaps concerned with the stimulation of the active processes in the tissues. These are copper, manganese and perhaps yet other undiscovered elements. Their deficiency is regarded to be responsible for certain forms of anæmia, though very recently this view has been doubted by some observers. The possibility of the existence of undiscovered mineral deficiency in disease is for the future to reveal, and may I suggest that certain obscure diseases of India, such as, infantile biliary cirrhosis of children may be investigated from this point of view.

Complicated are the inter-relations of the vitamins, the hormones and the mineral constituents of the tissues in the prevention of certain diseases. For instance, biochemistry has shown that a supply of iron, copper, vitamin C and thyroxin are the essential factors in the formation of erythrocytes and hæmoglobin, in addition to an active bone marrow. Deficiency of any of these may give rise to certain types of anæmia. A generous supply of calcium and phosphorus together with a liberal supply of vitamin D is essential for the perfect development of the bones and teeth of the child.

In recent times, studies in nutrition have been concerned chiefly with the maintenance of normal health and production of a rapid rate of growth. It has, however, been observed still more recently that prolongation of life associated with a retarded rate of growth has been noted in many divergent forms, such as, rats and

brook trout and that animals kept on a restricted food intake for long periods outlived by a wide margin those that were allowed to eat full from the time of weaning. The inverse relationship of the rate of growth and the time of onset of senility is also apparent from other investigations. Evans has noted that animals injected chronically with preparations containing growth hormone of the hypophysis show evidence of premature senility. On the other hand, Lee and Schaffer have shown that administration of the pituitary growth hormone results in retention of juvenile chemical characteristics by the tissues. Other clues for the study of these problems are furnished by the facts that thymus extracts greatly increase the rate of growth and maturity while pineal extract seems to retard growth. Wetzel in his work on "Motion of Growth" has shown that excessive rate of growth during infancy and childhood is associated with excess of wasteful heat production and that this may have grave consequences. It is apparent that some of the current tenets in the field of nutrition require reconsideration in an effort to determine the optimal rate of growth for each period in life.

PHYSIOLOGY.

Recent researches have thrown light on the mechanism of the fundamental reflex reaction for the protection of the animals and have shown how with the evolution of an anti-gravity mechanism and of extended movement, the brain stem has become evolved to take over this increased responsibility. Magnus has analysed the various nervous stimuli from the periphery which are concerned in this very delicately co-ordinated mechanism. The new data have completely revolutionised our conception of the nervous system, and signs and symptoms of disease which hitherto could not be properly understood have now become capable of analysis.

In more recent years Sherrington and his school have worked more exactly on the relation of the nervous system to responses produced when it is active. These fundamental studies will no doubt throw much light on the changes so often observed in disease. His researches have shown that the centripetal impulses do not pass straight through the spinal cord, but at certain stations in the cord they are transferred into an enduring excitatory state which may in turn set up fresh impulses yielding the reflex discharges.

Adrian's researches have also added greatly to our knowledge regarding the exact nature of the impulses which pass along nerves in different conditions. With a most admirable technique he has studied nerve impulse and its origin with highly profitable results. He has come to the conclusion that change of potential may be of fundamental importance in the activity of nerve cells. He has shown that damaged nerve fibres set up impulses at very high frequencies and these perhaps play a part in sensation of pain, though sometimes impulses in the smaller slowly conducting nerve fibres may also be concerned in the physical mechanism of pain. He has been able to observe the activity of a single nerve cell and has shown that human voluntary contractions are regulated in exactly the same way.

In Russia Pavlov and his school have elaborated the reflex reactions of the higher parts of the nervous system. Their results are capable of considerable application to many of the higher human activities.

A. V. Hill has studied the nerve impulses with exquisitely sensitive apparatus from the point of view of thermal phenomena accompanying it and it is becoming clear that the nerve impulse consists of a transmitted physico-chemical event, the whole cycle of event comprising activity and recovery in the nerve being supported by the energy derived from metabolic oxidative processes, associated with the cycle.

Further it is possible to conceive "the nervous impulse as a succession of transformation of chemical into electrical energy, and conversely—these transformations being necessary by the structure of the fibres".

Haldane and his pupils have continued their well-known work regarding the control of respiration. Carbon dioxide, formerly looked upon as a product of excretion, to be got rid of as soon as possible, has been shown by them to be an essential stimulus to respiration. This discovery has been of immense value in modern anæsthesia. Further it has been shown by Yandell Henderson of Yale University that carbon dioxide is also essential for the tone of the blood vessels. Dale and Evans have shown that carbon dioxide is essential for the activity of the vasomotor centre, just as it is responsible for the activity of the respiratory centres. Barcroft has

shown the principles by which oxygen is transported by the blood. As a result of the work of Haldane, Barcroft and their co-workers, it is now possible to deal with respiratory distress and failure by more scientific methods than what was possible in former days.

Areas such as the cerebral and pulmonary vessels which were once thought to have a poor vasomotor supply have now been found to be much better supplied than had hitherto been imagined.

With regard to the heart, the earlier studies of cardiac disturbances by Mackenzie have played an important part in advancing our knowledge regarding the physiology of the heart, and the work of Starling and of Lewis has placed much of it on a strict experimental basis in more recent times. A new interpretation of the electro-cardiogram in disease has been recently evolved.

The discovery of the function of the carotid sinus by Hering and its study by Heymans have been of great value to physiology and to pharmacology as well. By the recognition of the activity of this sinus and its possible variations one can now explain many of the differences in response which hitherto have been a great drawback in experimental work. In the nerve connection of this sinus and the effect of pressure on it lies, according to some observers, the explanation of sudden death under gas anæsthesia.

One of the most important new facts discovered in recent years regarding digestion is the relationship of the proper functioning of the stomach to the production of blood, and the subsequent application of this to the treatment of pernicious anæmia. This work had its origin in the physiological studies of Whipple on the normal regeneration of blood after hæmorrhage and administration of liver. Following the same line of research Minot and Murphy found that administration of fresh liver had a remarkable curative effect on pernicious anæmia. This led to the recent liver therapeutics for treatment of the disease.

The researches of Castle, however, connected the etiology of pernicious anæmia with defective gastric secretions. Recent experiments of Meulengracht have shown that pernicious anæmia in human beings may be due to atrophy and inactivity of that part of the stomach which comprises the pyloric-gland region and may be said to have localised the seat of origin of pernicious anæmia in human beings. Thus stomach preparations for the treatment of pernicious anæmia may with advantage be producible from the pyloric-gland region.

From a physiological point of view, these experiments give the pyloric glands a function. As we know, it has hitherto been difficult to ascribe such a function to the pyloric glands and the special pyloric-gland cells. Now it seems possible that the pyloric glands are the seat of special secretory function and secrete the substance Castle's "intrinsic factor" that is essential to the blood and the nervous system.

It has been held that the ductless glands are the "glands of our destiny" and that "these potent overlords of our bodies are dictators of our minds and personalities". It may be possible that the future may reveal that genius, intelligence, beauty, character, morality, and other human characteristics are dependent upon diverse combinations of the secretions of these bodies, just as their deficiency or excess may give rise to disease.

Insulin has completely changed the prospect of the treatment of diabetes. The discovery that parathyroid extract mobilises the calcium of the bones has revolutionised the treatment of diseases due to calcium derangement. Our knowledge of the interaction of endocrines has increased in recent times. I would just mention a remarkable fact that, as shown by Houssay and co-workers, there is no glycosuria when both the pituitary and the pancreas are removed, and further that the injection of extract of the anterior pituitary is followed by the appearance of glycosuria.

May I end this portion of my address by making a little more reference to the pituitary, which seems to have a multiplicity of functions? It may be regarded as the headquarters for the hormones or the chemical messengers which control most of the other endocrine glands and thereby probably almost every cell of the body. The chemistry of the pituitary is by no means closed and it may be that the most important discoveries in the pituitary chapter have yet to be written. It has been held that "the integration of the endocrine system is based on the influence of the diencephalon upon the anterior pituitary, which through complex hormones acts on the other endocrine glands, stimulating or inhibiting the production of simpler hormones in them. These hormones are closely related chemically

to other substances concerned in normal activities, such as, the growth of the embryo, the growth of bone and calcium metabolism, as well as abnormal activities such as malignant growths." Further, "in general we can see a division of labour between nervous and hormonal events, and accordingly between the respective regulators, the central nervous system, and the anterior pituitary lobe. The central nervous system regulates principally the specific, acute functions; therefore it also influences those neurogenic endocrine organs, the adrenal medulla and the posterior pituitary lobe, the hormones of which cause acute changes. The regulator of the non-neurogenic hormonal system, the anterior pituitary lobe, regulates mainly the development and state, and partly also the secretion, of the remaining endocrine organs, the hormones of which bring about longer lasting changes of the conditions of many other organs" (Lœwi).

GENETICS.

The account of Mendel's epoch-making experiments in his cloister garden, on the crossing of varieties of the common pea, somehow or other sank into oblivion for thirty-five years. But such was the potentiality of his work that, when rediscovered, it not only laid the foundation but also gave a new impetus to the study of the science of heredity. In recent times Mendel's theory of what were called by him *factors* (now known as *genes*) has received confirmation in the hands of Morgan and others. Their physical existence in the chromosomes has been proved and it is now known that the chromosomes are indeed the bearers of the hereditary units and that to their very reliable mechanism we owe the regular behaviour of the inheritance of characteristics from parents to children. Heredity is really a most remarkable phenomenon. The production, generation after generation, of offsprings identical in all but minor peculiarities with their parents is indeed one of the great mysteries of life, and it is by the orderly division of the chromosomes and their contained genes life can be maintained. It is becoming more and more established that "the general laws laid down by Mendel have as wide a validity for genetics as have Dalton's for chemistry".

The practical outcome of the application of the principles of genetics as demonstrated by the magnificent work in research laboratories such as those at Cambridge, Edinburgh, Aberystwyth and Aberdeen, has been of immense value in improving crops and live-stock. The boundless possibilities in heredity revealed by the science of genetics have placed great power in the hands of breeders of plants and animals and they can now tell with approximate accuracy what to expect from matings. This knowledge has revolutionised breeding in all directions, and resulted in the production of bigger and better plants and animals used for food, clothing or pleasure. In the course of time man may be able to replace the natural selection of more fertile mediocrity and the artificial sterility of high-grade parents by human selection and the artificial fertility of high-grade parents. Sooner or later the frequency of the latter would increase in geometrical progression and control and guide the qualities of mankind in any way it desires for the good of man. The future trend of creative evolution, including man's own destiny, depends on his response to the new knowledge and on his intelligent application of genetical discoveries, in the near as well as distant future (Hurst). Genetics aided by better environments may also be able to prevent the transmission of hereditary weakness and hereditary diseases, some of which are sex-linked. In this way it may lead to the production of better type of men, free from diseases of the mind and body that are propagated from father or mother to their children and thus the difficult task of medicine for averting or curing hereditary diseases or diathesis will be reduced to a minimum.

CHEMISTRY.

I begin with the recent contributions in therapeutics due to the application of chemistry. If I were to attempt to enumerate the various compounds that are brought every day to the notice of the medical profession in recent times, as hypnotics, anæsthetics, analgesics, antipyretics, antiseptics, or for other therapeutic purposes, then their number will be legion and my task may be impossible. I shall therefore refer briefly to a very few principal therapeutic chemicals of recent times.

How complicated is the mechanism of chemotherapy is shown by the fact that a slight alteration in the constitution of a compound may bring about a complete

change in its physiological properties. This is well exemplified in the preparation of the various amino-quinoline derivatives for anti-malarial purposes. A slight change in the constitution of these compounds leads to a complete disappearance of these properties. 6-amino-quinoline and 8-amino-quinoline have no action on paramœcia in strength of 1 : 4000. The introduction of OH into 8-amino-quinoline and quinoline-8-glycine-amide raises their toxic action on paramœcia to a remarkable degree and the methylation of 6-oxy-8-amino-quinoline by replacement of H of OH by CH_3 reduces its action on paramœcia to nil (Brahmachari and co-workers). Diethylmonosulphone is without hypnotic action, while both dimethyl-sulphonediethylmethane and the isomeric diethyl sulphonedimethylmethane (sulphonal) are strongly hypnotic.

There is no doubt that general anæsthetics have been conducive to the advance of all branches of medicine. "The medical sciences, physiology, pharmacology, pathology and bacteriology would have remained inaccurate and incomplete hand-maidens of medicine, had it not been made possible by the aid of anæsthesia to critically examine, corroborate or disprove the claims, hypotheses and tenets of workers of all types" (Stander).

I now pass on to certain aspects of chemistry in its application to a few protozoal diseases as revealed by recent researches.

The best known of trivalent organic arsenicals is salvarsan, for which the non-proprietary name arsphenamine is in common use in the British Empire and the United States. The drug is now generally used in the form of one of its two principal derivatives. The first of these is neo-arsphenamine, the second is sulph-arsphenamine. The first pentavalent organic arsenical used in the treatment of trypanosomiasis was atoxyl. An important derivative of atoxyl is tryparsamide. It has been found very successful in the treatment of trypanosomiasis. Other new therapeutic organic arsenicals include stovarsol, etharsanol, proparsanol and carbarsone.

The first and best known of the symmetrical urea group of trypanocidal drugs is Bayer 205 or germanin. In 1924 Fourneau and collaborators described the production of a symmetrical urea, which is now obtainable in France under the name Fourneau 309 (moranyl) and is identical with Bayer 205.

Schulemann and his colleagues succeeded in increasing the anti-malarial properties of methylene blue by replacing its short side chains by a longer chain. Investigation subsequently conducted with the quinoline nucleus led to the discovery of beprochin afterwards named plasmochine or plasmoquine. Similar experiments were made later with other heterocyclic nuclei including acridine and this led finally to the discovery of atebrin. These compounds are of great therapeutic value in certain forms of malaria. In Calcutta a number of amino-quinoline compounds are being synthesised under the speaker's direction and their anti-malarial properties tested. Some of them have already been reported to have a marked action upon paramœcia.

One of the most terrible of tropical diseases, so far as certain parts of India are concerned, is *kala-azar*. Antimony, which was once banned to such an extent that the graduates in medicine of the University of Heidelberg had to swear never to use it, has now been found to be its specific. By the introduction of organic antimonials in its treatment, the mortality of this disease has been reduced from 99% to about 1 or 2% in uncomplicated cases. The terrible nature of this disease in its epidemic form when it ravaged Bengal in the Seventies was well described by a contemporary writer as follows :—"The devastation of the epidemic has a very sad tale to tell. Countries that once smiled with peace, health and prosperity, have been turned into hot-beds of disease, misery, and death. Villages that once rang with the cheerful, merry tone of healthful infants, now resound with loud wailings and lamentations. Huts, which offered too little space for their occupants are left without a tenant. The skulls of human beings now strew the fields at every few yard's distance. The fell disease has mocked every human effort, and absorbed in its powerful grasp, day by day and inch by inch, every blessed spot which once used to be prized for its salubrity" (Roy).

The next step in the treatment of the disease was the introduction by the speaker of the intravenous administration of metallic antimony in a state of fine subdivision, which was attended with remarkable benefit. It was observed that when injected intravenously the particles of antimony are picked up by the same cells in the spleen as those that harbour the parasites of *kala-azar*,

that the two contending agents thus come in closest contact with each other in these tissue cells, and that the fight ends most remarkably in the complete destruction of the parasites in the speediest way.

The next further advance in the treatment of *kala-azar* was the introduction of certain organic compounds of antimony and the use of these compounds in *kala-azar* infection has been the subject of the speaker's research for many years, and in 1920 some of them were prepared for the first time in India in the Calcutta Campbell Hospital.

Early in 1921, the speaker discovered an urea antimony compound for the treatment of *kala-azar*. Its introduction and his other researches on antimonial compounds opened up a new vista in the treatment of the disease in India by means of therapeutic organic antimonials, just as the discovery of salvarsan led to the introduction of organic arsenicals in the treatment of spirochætal diseases. This urea compound was named "urea stibamine".

Dealing with the relationship between chemical structure and physiological properties one meets with a remarkable series of compounds in recent times having a common nucleus but possessing varied physiological properties. I mean the compounds having the condensed benzene ring system or phenanthrene, as well as, the reduced phenanthrene *plus* a fourth five-membered carbon ring or cholane. The cholane nucleus is found in bile acids, cholesterol and other sterols.

A structure of the cholane type is also found in the sex hormones which are responsible for the secondary sex characters of animals. These hormones are œstrone, luteosterone and the male testicular hormone or androsterone. They have close structural relationships with each other and with bile acids and cholesterol which probably contain their biological precursors.

The male sex hormone or androsterone has been artificially prepared. Friedmann has pointed out that the aromatic ring, corresponding to ring A of œstrin is not necessary for the development of the œstrogenetic effect as the benzene nucleus can be replaced by the furane ring, fural pyruvic acid being even more active than benzal-pyruvic acid. Recent experiments suggest the possibility of getting œstrogenetic activity in ring-free compounds by arranging the carbon atoms 13, 14, 8, 9 of œstrin in a suitable way.

Synthetic hydrocarbons containing the phenanthrene nucleus, such as dibenzanthracene, are found to possess carcinogenic properties. The cancer-producing action of certain tars is due to the presence of a hydrocarbon allied to dibenzanthracene. It has been synthesised and the powerful carcinogenic action of the pure substance has been confirmed. It is, perhaps, the most potent carcinogenic substance so far discovered.

The aglucones, that is, the non-sugar parts of digitoxin, strophanthin and several other closely related substances are allied to the sterols as they embody structures of four carbon rings. Bufotoxin has a constitution closely allied to those of the cardiac aglucones and possess a characteristic action on the heart similar to that of digitalis preparations. The phenanthrene nucleus is present in some of the most powerful alkaloids, such as morphine and codeine of the opium group, and the corydalis alkaloids and in colchicine.

All hormones of the secondary types contain benzene rings. In some cases the ring is a simple one as in thyroxin, pituitrin and adrenalin. In others it is a complicated one, the condensed phenanthrene ring. The Needhams and Waddington have observed the most remarkable phenomena that the chemical organiser or, as they call it, the evocator which determines certain developments of the embryo, belongs to the same group.

X-ray work on vitamin B_1, B_4 and C has been carried out in recent times and the structural formula of C as *l*-ascorbic acid has been established by a close collaboration of crystal analysis with the ordinary chemical methods.

The structure of carotene and vitamin A has also been established by X-ray analysis, as consisting of *cis*-polyene chain which is presumably the chain of polymerised rubber.

Vitamin B_1 possesses two ring systems, one a glyoxaline or pyrimidine and the other a pyrrole containing a substituted sulphur. It is not allied to flavins. Vitamin B_1 possesses anti-beriberi properties. The crystalline specimens of Jansen and Donath are, according to most recent observations, the pure vitamin itself with the admixture only of a small and variable amount of inactivated vitamin.

Vitamin B_2 is a complex, containing flavin and another factor, the absence of the latter and not of flavin being considered responsible for the symptoms of pellagra in rats. The flavin factor exerts a growth-promoting action. A substance identical with lacto-flavin of milk which is allied to vitamin B_2 has been isolated and synthesised. Examining the oxidation-reduction properties of flavin-cleavage products, Kühn and Moruzzi were able to sum up the relationship of the flavin group by saying that the parent substance was a reductant; that combined with a ring system which contains a substituted amino group it produced a colour; that the addition of a carbohydrate side chain yielded a vitamin; and that the further addition of a protein group resulted in an enzyme (the yellow respiration ferment of Warburg).

Vitamin C is closely related to simpler carbohydrates and sugars. It is a keto-hexonic lactone.

Vitamin D can be artificially prepared from irradiation by ultra-violet rays. It has been isolated from irradiated ergosterol in a crystalline and apparently pure form, the crystalline compound being known as calciferol. The production of vitamin D by the irradiation of the sterols of the skin by ultra-violet rays of the sun is a most interesting chapter in the history of medicine, reconciling, as it does, the dispute whether rickets is due to a deficiency in the diet or want of proper sunlight.

The discovery of type specific carbohydrates are among the most remarkable triumphs of chemistry in recent times. It has been observed that a derivative of gum arabic possesses properties resembling those of the specific polysaccharides of one of the types of pneumococcus serum. The value of polysaccharides possessing immunological functions, and the knowledge of their composition, properties and structure must be of great value in medicine. The polysaccharides of the cholera bacilli and of B. dysenteriæ (Shiga) have been investigated.

Vernadsky has put forward a hypothesis that the living organisms possess a selective power between isotopes of an element. Among the plants, Loring and Druce have shown that in the potassium of potatoes isotope of atomic weight 41 predominates while in ordinary potassium the chief isotope is of atomic weight 39. In the case of man the future may reveal that isotopes of elements play an important part in the maintenance of health and that they may vary in disease.

Barnes has suggested that the polymerised molecules of water are of primary importance in physiological processes. The discovery of the hydrogen isotope (deuterium) of mass 2 and the isolation of quantities of "heavy water", containing this isotope have opened a new field in the physiology of water. Gortner considers that the water in the Medusa is as much "alive"as are the proteins, the fats, the lipides, or the carbohydrates. The water relations and different molecular forms of water in the living organism lie at the foundation of problems concerning both health and disease. It has been held by him and others that in lyophilic hydrosols and hydrogels the water may exist in two states, *i.e.*, in the state of free water which is characteristic of water in bulk and in the state of bound water which is characteristic of the lyophilic system, and that the equilibrium between free and bound water is undoubtedly of major importance in vital phenomena. Two hypotheses have been presented as to the possible nature of bound water: (1) an oriented adsorption of the water dipoles at the interface, and (2) an oriented adsorption of hydrogens and hydroxyl ions. The effect of the substitution of the deuterium form of hydrogen in place of ordinary hydrogen and of the isotopes of other elements into organic molecules may have in the future an important application in biochemistry and medicine.

PHYSICS.

The Electro-cardiogram is a valuable apparatus for studying certain diseases of the heart. A portable apparatus which can be taken to the patient's house and which is constructed on the principle of the string galvanometer is now available. Another portable Electro-cardiograph based on the principle of the valve-amplifier is also available. By means of a special Electro-cardiograph outfit, simultaneous records of a heart may be obtained in the wards of a hospital for purposes of research showing (1) heart sounds, (2) electro-cardiogram, and (3) carotid pulse by means of Hill's wire sphygmograph. An apparatus consisting of a Stethograph combined with an Electro-cardiograph is now available. The combined Electro-cardiograph Stethograph may prove a valuable aid in cardiology.

The Electro-cardiograph has shown that tracings taken of patients dying of various maladies can demonstrate that for some time after clinical death, some cardiac activity could be registered, the duration varying from six to twenty minutes. These observations show that in cases in which there is cardiac stand-still during anæsthesia or in the new born, resuscitation may be effected by timely cardiac injection or needle puncture. There may be other conditions that may be discovered in future in which the same may be possible.

It may just be mentioned here that a convenient new method of assay of vitamin B_1, based on electro-cardiographic measurements, has been recently described.

One of the most recent advances in biophysics is the discovery of some electrical phenomena in the human brain, which were originally studied by Berger and subsequently by Adrian and Matthews, the latter observers using the Matthews' Oscillograph constructed on the principle of a valve amplifier. The electrical changes consist of a rhythmic oscillation of potential with a frequency of about 10 per second appearing when the person experimented upon lies quietly with eyes closed and disappearing when his attention is fully occupied. Non-visual activities which demand the entire attention, *e.g.*, mental arithmetic, as well as sensory stimuli demanding the same, abolish the waves.

Berger considers that this "Berger rhythm" represents the normal activity of every part of the cortex of the brain while the experiments of Adrian and Matthews point to the conclusion that they arise from the activity of cortical cells in some parts of the optical lobe connected with vision.

Concluding Remarks.

Forecast.

From what I have stated, it is clear that the various sciences can be of great service to MEDICINE. Some of them have contributed very substantially to the relief of human suffering from disease. They can obtain valuable findings for the clinician in diseased conditions which may be helpful to him, but the responsibility finally rests with him as to how to act upon their findings. This shows the great importance of what is called to-day Clinical Science. Anatomy the science of structure of the body, physiology the science of function and the meeting ground of physics and chemistry in their application to problems of health and disease, and biochemistry the science concerned with the chemical processes underlying the activities of living matter, can be of great service to the clinician. In recent times, the need for increased application of physics and chemistry to medicine has grown with tremendous rapidity.

Sectional Addresses.

MATHEMATICS AND PHYSICS.

President: DR. T. ROYDS, D.Sc., F.N.I.

SOME SOLAR PROBLEMS.

DR. ROYDS drew attention to some problems concerning the sun which have recently been under investigation at Kodaikanal. The first problem is concerned with the relation between prominences at the sun's limb and dark markings on the surface of the sun's disc. The different ways of deducing the height of dark markings agree in giving the same average height as for the prominences at the limb. It is concluded that the prominences and the dark markings are different aspects of the same solar phenomenon. At the limb we see its profile, and on the disc we see its projection. This phenomenon which is exhibited in the sun by the prominences and dark markings consists of a long line of flame, the length along the sun's surface being generally enormous compared to the height above the surface and to the width. The average width is about 7,000 miles, height 14,000 miles, but their length frequently extends to 400,000 miles or more.

The force which can support the sun's chromosphere to the great heights observed has long been a problem. Gas pressure could only support an atmosphere on the sun to a height of 60 miles whereas the chromosphere is observed to a height of 6,000 miles or more. Milne's theory of selective radiation pressure as the supporting force is the only theory which has been even partially successful. A theory of great simplicity, it has explained not only the great heights reached by ionised calcium but also how calcium prominences may be driven away from the sun's surface as is occasionally observed. The great difficulty of the theory is to explain the presence of hydrogen, helium and oxygen in the chromosphere when the radiation pressure on all three of them is insignificant. Photographs recently obtained at the Kodaikanal Observatory show that oxygen is a normal constituent of the chromosphere and is present in great abundance. Hydrogen, helium and oxygen are the three most abundant elements in the sun, and their presence in the chromosphere seems to show that abundance in the sun is the main criterion for presence in the chromosphere. Yet the

rôle of radiation pressure on ionised calcium is not insignificant, for it seems to be effective in raising the small fraction of calcium in the sun's composition at low levels to such heights as are only otherwise attainable in appreciable quantity by the abundant elements.

New ideas of the formation of absorption lines have led to work being begun in a large number of observatories on the study of the intensity of light within absorption lines of the sun's spectrum. These studies are intended to enable us to count the number of atoms in the atmospheres of the sun. Various technical difficulties are involved in the accurate photometry of spectrum lines. At the Kodaikanal Observatory, the photometry of some of the strongest lines in the sun's spectrum has been carried out for different points on the sun's disc. The lines studied are mainly those of calcium and of hydrogen. It is found that the equivalent widths of the lines of calcium and hydrogen diminish towards the limb of the sun notwithstanding the fact that near the limb the line of sight through the sun's atmosphere is greatly inclined to the sun's radius. This problem is related to the darkening of the sun's disc towards the limb. As a result of the measures made at Kodaikanal, the densities and pressures of the deeper portions of the sun's reversing layer have been deduced.

CHEMISTRY.

President: DR. P. C. GUHA, D.Sc., F.N.I.

RECENT DEVELOPMENTS IN THE CHEMISTRY OF BICYCLIC TERPENES.

THE address on recent developments in the Chemistry of bicyclic terpenes gives a review of the work of a small group of substances occurring in essential oils, covering, however, too vast a field to be satisfactorily compressed into a lucid address. Only the briefest reference being made to many complex aspects, the compilation may be difficult to follow by those not conversant with the particular field. Opening with a description of the bicyclic ring systems in general, he refers to 0 : 1 : 1 butane-2 : 3 : 4-tricarboxylic acid prepared by Beesley, Ingold and Thorpe in which two cyclopropane rings are fused together, to Zelinsky's bicyclo-0 : 2 : 2-hexane, to Huckel's and Rao's work on isomerism in decalin, and to Linstead's on stereochemistry of bicyclo-octane derivatives. Azulene is not, as stated in the address, a sesquiterpene hydrocarbon but has a formula $C_{15}H_{18}$. The claim of Khuda about four forms of 4-methyl-cyclohexane-1 carboxy-1-acetic acid appears doubtful in view of the investigations of Linstead, Desai and Hunter. The references at the end, if the textual errors are eliminated, should be of value to those who have inclination for work on these lines. The section closes with a reference to the ingenious preparation by Guha of *p*-bridged-diketo ester from ethyl disodio-succino-succinate and ethylene bromide (*Ind. Sci. Cong. Abs.*, 1935).

The parent hydrocarbon of the camphor group norbornylane has recently been synthesised by Komppa (*Annalen*, 1934, **512** 172). "With the exception of camphene, borneol, fenchyl alcohol, camphor and fenchone, practically all the other fundamental compounds from which an amazing number of complex substances are derived, have been obtained artificially in the laboratory and it is with them that we are mainly concerned." But it is doubtful if these numerous substances by many investigators have any other than laboratory interest and filling the pages of Beilstein. In quite a number of the synthesis referred to in this address the original methods of Perkin, described between 1885–1895, have been adapted, the yields of many of the products however, being of a low order. The recent synthesis of endocamphene camphenic acid, *d*- and *l*-epicamphor, α-fenchene, fenchone, Balbiano's acid and isolaurolonic acid by Lipp, Bredt, Bardhan, Lapworth and Ruzicka are then alluded to. After a brief reference to Nametkin and Wagner rearrangements the reader is amidst the physiological action of camphor derivatives, an aspect unrelated to the rest of the address. Attention is then drawn to several isomeric santenols and santinic acids described in literature, to synthesis of santene from methyl-norcamphor by Diels, and of santene glycol by Ray.

The difficulties of work in the thujane series due to lack of crystalline derivatives, racemisation, isomerisation are referred to, as deduced from the work of Kondakow, Henderson, Zelinski and Paolini. Simonsen's work on carenes, his recent synthesis of *cis*-homocaronic acid, Ebel and Mangelli's synthesis of norcarane and synthesis of Guha and Ghosh in this series have been alluded to. α-pinene is widely distributed in nature though it may not be right to say that β-pinene is just as abundant. Reference is made to the work of earlier investigators like Wagner and Tiemann in this group and more recent work of Komppa, Lipp and Ruzicka on synthesis of pinenes, pinocamphone and nitrosopinene. Kerr's synthesis of norpinic acid is then described and reference made to other methods. There have been numerous recipes for norpinic acid since 1890 but in the interest of future workers who may want a small specimen of synthetic acid it may be desirable to state that the only method which gives it, so far, is Kerr's method. Under one of the sub-titles in the address, "Natural hydrocarbons obtained artificially" one looks in vain for such an example; the homologues of pinene do not occur in nature. After alluding to failures to form a cyclobutane ring in a cyclohexane derivative by internal bridging, reference is made to the synthesis of keto-nopinone in support of which one would as well await more evidence. The important degradation products of pinene are then touched upon and it is said that

> "The experiment of Schmidt is of great importance as contrary to the statement of Simonsen, it proves the presence of the cyclobutane ring in β-pinene. By ozonising β-pinene he obtained nopinone and another product $C_{16}H_{16}O_2$ which on oxidation with permanganate gave pinonic acid."

Simonsen (*Terpenes*, **2**, 169) states there is no direct evidence of the presence of a cyclobutane ring in nopinone since neither nopinone nor β-pinene yield any acids of the pinic acid series. Schmidt obtained in his experiments mainly nopinone and small quantities of pinonic acid and its aldehyde. The latter were obviously formed from α-pinene contaminating Schmidt's

β-pinene. Schmidt's experiment does not appear to have been properly understood and it does not affect the contention of Simonsen.

Attention is drawn here and there in the course of the address to gaps in work which may be suggestive to investigators who have to be grateful to the President for this excellent review.

GEOLOGY AND GEOGRAPHY.

President: MR. B. RAMA RAO, M.A., D.I.C., F.G.S.

RECENT INVESTIGATIONS ON THE ARCHAEAN COMPLEX OF MYSORE.

EVER since the startling inferences of the Mysore Geological Survey were voiced in 1916, by Dr. W. F. Smeeth regarding (1) the igneous origin of the types of which the Dharwar schists are composed and the autoclastic nature of most of its conglomerates, (2) the intrusive relationship of the granitic gneisses towards the schists and (3) the absence of the basement rock on which they could have been formed, later discussions on the Archæan rocks of Peninsular India have mainly centred round these contentions. The Presidential Address of Mr. B. Rama Rao (Director of the Mysore Geological Survey) deals with these and other controversial problems of the Archæan Complex in the light of later investigations of the Mysore Geological Survey.

Structural characteristics of shallow water facies of sedimentation like current bedding, ripple marks and rain prints have been recently discovered in some of the exposures of quartzites of widely separated areas, and the results of chemical analyses of the associated phyllitic and micaceous schists and the highly altered types like cordierite, sillimanite gneisses and kyanite graphite schist indicate likewise a sedimentary origin. In the case of limestones and the banded ferruginous quartzites, the evidences are not always clear, but their intimate association with other recognisable sediments and the occasionally preserved relics of signs of original stratification are suggestive of *their* aqueous origin also.

With the recognition of distinct horizons of these different sediments, the Dharwar schists of Mysore can be classified into three series, not so much on lithological grounds, but on recognisable stratigraphic breaks as indicated by two well-defined sets of basal conglomerates. The lowest series consists mainly of igneous material—acid and basic intrusives, deformed lava flows and ashes. The other two series consist largely of sediments with intercalated beds of ashes, tuffs and flows. In the northern parts of the State these three divisions are noticeable, but as the belts of schists are traced southwards, the uppermost division disappears, and the lower two are found considerably cut up and often scattered as stringers of altered schists in the gneissic complex.

One of the common constituents of all these divisions is the banded ferruginous quartzite. The mode of origin of the type of the lower division is not clear, perhaps it is a case of silicification and replacement of a minutely fissured pyriteferous chert or felsite. The banded hæmatite quartzites of the middle division have originated as chemical precipitates while the ferruginous rocks of the upper division form typical products of sedimentation produced by the disintegration of the older members. Many of the ferruginous quartzite bands of Mysore are found to be of the middle division, those of the other two being of very small areal extent.

In correlating the Mysore facies of the Dharwar schists with other Dharwarian rocks of the Peninsular India on purely lithological grounds, such as the occurrence of the ferruginous quartzites or some dark hornblendic schists, the precise mode of origin of the types and their position with reference to the granitic rocks will have to be taken into consideration. There has been as yet no consensus of opinion on the correlation of the Dharwarian rocks of different parts and to formulate any authoritative statement on the subject, it is desirable that the various tracts of the "Dharwar schists" of Peninsular India should be examined conjointly by a selected committee of geologists having special experience of the regions they represent.

Recent investigations on the granitic complex of Mysore, disclose only *two* different periods of eruptive epochs and not four as till now believed. The older of these two granitic series has intruded subsequent to the Middle division of the Dharwar schists of Mysore, but before the upper division rocks were formed, and the younger series has intruded long after the entire period of the Dharwars.

The terms "Champion gneiss" and "Peninsular gneiss" as hitherto adopted by the Mysore Geological Survey stand in need of modification. In the former are found included unrelated rock types of different periods of formation all characterised by the accidental occurrence of blebs of opalescent quartz. The various types of granitic rocks which have been differentiated till now as of the series of "Champion gneiss" and of the "Peninsular gneiss" are found to be the modified products of consolidation of a single eruptive magma. Magmatic stoping has played a large part in the process of emplacement, and the incorporation and disruption of such stoped out blocks, combined with varying extents of their assimilation, have given rise to numerous types of granitoid gneisses. The term "Champion gneiss" is proposed to be retained for distinctly intrusive granites of the older series, and "Peninsular gneiss" as a descriptive term for the large areas of gneissic complex, the character of which requires further closer investigations. It is believed that parts of the basement on which the Dharwar schists had been formed might be existing as unrecognised islands in this complex.

The granulitic hypersthene rocks of Mysore, comparable in character to the Charnockites of Southern India are found to have resulted by the metamorphism, under varying conditions, of several unrelated rock types, all of them being older than the granitic intrusives. They do not form in Mysore any related series of differentiated phases of a normal eruptive rock, intrusive into the granitic gneisses, as is believed to be the case with the Charnockites.

These recent conclusions, naturally, require further verification and owing to the different orientations they would give to the general interpretation of the geological history of the gneissic complex of Peninsular India, it is hoped that the problems will be critically investigated in greater detail both in Mysore and in the rest of the Archæan tracts of Peninsular India.

BOTANY.

President : DR. S. R. BOSE, PH.D., F.R.S.E., F.N.I.

BENGAL *POLYPORACEÆ*.

IN his Presidential Address on Bengal *Polyporaceæ* Dr. S. R. Bose has dealt with the various aspects of *Polyporaceæ* he has studied in the course of last twenty years, for instance, he has discussed the importance and origin of fungi, has recorded the previous history of Bengal *Polyporaceæ* which is really a record of scrappy work done at irregular intervals. He has dealt with geographical distribution of Bengal *Polyporaceæ*, the conditions for their development in Bengal, the general nature of the soil of Bengal, the Fossil records of *Polyporaceæ*, their morphology and systematics, the anatomy as the basis of recent classification, their general structure, nutrition, cytology of reproduction and the chemical nature of fruit body of *Ganoderma lucidum*, their biological peculiarities, their physiology and medicinal properties and other uses.

Under the geographical distribution he has noted that when climatic conditions such as temperature, rainfall, humidity, etc., are analogous, it is astonishing to find the repetition of the species in very distant parts of the globe. Recently in 1935 he has recorded the occurrence in the high hills of Lokra (Assam) in Bengal 8,000 to 10,000 ft. elevation of six European *Polypores* (*P. squamosus, P. sulphureus, P. gilvus forma licnoides, Fomes fomentarius, F. pinicela, Amaroderma rugosus*), which are never found in the plains of Bengal. This is probably because most of the plants of the high hills harbouring these species of *Polypores* as parasites or saprophytes do not grow in the plains.

Prof. Bose is of the opinion that for the establishment of stable classification of *Polyporaceæ* morphological studies should be supplemented by detailed study of anatomical, cytological, cultural, physiological, and biological, chemical and other characters, and that the old classification, however imperfect, should not be changed till we have accumulated data from the completed study of these diverse aspects of *Polyporaceæ*.

In connection with cytology-study it was found that the tramal hyphæ and the basidia were regularly bi-nucleate, two nuclei in the basidium coming into contact with each other gradually fused into one large fusion-nucleus with two prominent nucleoli. The process of nuclear fusion in the basidium of *Polypores* followed by two quick divisions (usually first meiosis and then mitosis) is regarded as a very much simpler type of fertilisation prevalent in the higher fungi; this process of nuclear divisions corresponds fundamentally to meiosis in higher plants. The chromosomes here are extraordinarily small, they could not be satisfactorily counted. According to the author the vacuolar bodies in basidia of *Polypores* correspond to Golgi-bodies so often described by Gatenby in animal cells and that the solid Golgi-elements are nothing but artifacts due to the excessive precipitation of metallic silver or osmium inside the vacuoles.

The chemical analysis of the fruit-body of *Ganoderma lucidus* with a strongly laccate upper surface shows that it contains resin, ergoster, ergosterin, fatty acids, mannite, some polysaccharides and voluminous deep-brown amorphous substance much resembling humus acid. The study of biological peculiarities of *Polypores* shows that mostly as saprophytes or parasites some species grow singly on logs or trunks and branches of forest-trees, while others have a gregarious habit. The decays in wood according to the gross characters of the rot are known as *white rots* and *brown rots*, depending on the colour; in the former case the wood becomes lighter in colour and in the latter it acquires a dark-brown or reddish tinge. Some species have corky or leathery fruit-bodies; others have hairy or soft and velvety upper surface. As soon as the rains begin to appear, they set forth in an advancing zone which is quite marked off from the old zone. Some *Polypores* begin their lives as saprophytes, attacking dead roots, stumps and branches, they then extend their hyphæ round the living cells in the adjoining portions and thus become converted into parasites. Others begin their lives as parasites, their spores usually entering through a wound, then they kill the living portion and finally establish themselves as saprophytes with a number of sporophores on dead parts of the plants. In extreme cases the whole central cylinder (heartwood) is destroyed, converting the tree into hollow structure. Some again rarely continue their activity after the tree has been cut and converted into timber.

Interesting studies on spore-discharge from dried fruit-bodies of *Polypores* have been carried out, only those that have basidia revive under the moist condition and shed spores after varying periods of desiccation (weeks, months or years), specimens without basidia never shed spores. Brown and coloured *Polypores* do not survive desiccation long, when detached from the host; they shed spores only for a short time in the fresh condition. Recently the author has reported that in specimens of *Ganoderma lucidus* and *Ganoderma applanatus* the basidia are succeeded after the rains by hyphæ projecting direct from the trama and bearing secondary spores at their tips, which are indistinguishable from the ordinary basidiospores in any way; probably these carry on spore-discharge in the dry season. It is a matter for future investigation whether the basidia themselves are transformed into such tramal hyphæ projections. There are a few instances where there was copious spore-discharge though not a single basidium was visible under the microscope, probably in the cases the tramal hyphæ projections carried on the spore-discharge. In November 1935, the author observed that after an unexpected shower of rain specimens of *Ganoderma* which had their basidia almost replaced by direct tramal hyphæ, reverted to basidia-formation.

Complete life-history studies of about a dozen local *Polypores* from spore-germination to the final fructifying stage have been carried out, the details have been published in the *Journal of Linnean Society* in 1930. It is found that these *Polypores* can fruit on a wide range of media irrespective of their special host. No special decoction is necessary for their spore-formation, almost all of them fruited in malt-extract-agar medium.

Recent studies on the determination of sexual reactions of *Polypores* by means of monosporous cultures show that most of them are heterothallic

and are potentialiy bisexual. This theory of potential bisexuality, first put forward by Ames in 1932, seems to cover most of the facts in various groups of fungi, though in two local *Polypores* the author has shown two sexes are of a comparatively stable character and not easily interchangeable according to the varying conditions, as is the case with various groups of lower fungi examined by different workers from time to time.

From the enzyme study of some local *Polypores* it appears that in each case there is a marked decline in the activity of enzymes as the fungus passes from purely vegetative state to the fruiting condition, that in the fruits formed in nature the activity becomes still less (but in the case of catalase slight increase of activity in the fruiting stage in artificial cultures has been noticed) and that extracellular enzymes are much more active than intracellular ones. The enzymes of the following groups were found:—(*a*) carbohydrate-splitting, (*b*) proteolytic, (*c*) lipolytic, and (*d*) oxidising enzymes. It is well known that secretion of enzymes varies qualitatively and quantitatively according to the nature of the medium of the fungus, having used malt-extract medium in all these cases the predominance of carbohydrate splitting enzymes was noted.

ZOOLOGY.

President : DR. H. K. MOOKERJEE, D.Sc. (Lond.), D.I.C.

THE DEVELOPMENT OF THE VERTEBRAL COLUMN AND ITS BEARING ON THE STUDY OF ORGANIC EVOLUTION.

PROF. H. K. MOOKERJEE of the Calcutta University dwelt, in his Presidential Address in the Zoology Section of the Indian Science Congress on "The development of the vertebral column and its bearing on the study of organic evolution". He said, evidences furnished by palæontology are imperfect owing to gaps in our knowledge of extinct forms. The theory of recapitulation is a real help in the matter of tracing the lines of descent where morphology fails. Hence, embryology rises greatly in interest in the study of the theory of evolution which means descent with modifications. Prof. Mookerjee has chosen in his address the development of the vertebral column as the latter offers a stable character of great morphological value in tracing the lines of ancestry of the vertebrates. The subject has been treated by him under the following heads :—

1. Formation of the centrum.
2. Formation of the arches.
3. Formation of the rib and the rib-bearing process.
4. Formation of articulations.

The late Prof. Hans Gadow classified the vertebræ according to the mode of formation of the centrum. His divisions are :—

1. *Chordacentrous.*—The sheaths of the notochord become the centrum by the migratory mesoblastic cells that get inside at the base of each arch which ultimately chondrifies as in Elasmobranchs.

2. *Archocentrous.*—The arches play an important rôle in the formation of the centrum. There are three sub-divisions of this :—

(*a*) *Pseudocentrous.*—Four pairs of arculia, *viz., basidorsalia, basiventralia, interdorsalia* and *interventralia*, take part in the formation of the vertebral centrum, as in the caudal vertebræ of Urodela.

(*b*) *Notocentrous.*—The centrum is formed by *basidorsalia, interdorsalia* and *basiventralia*, as in the trunk vertebræ of Anura.

(i) *Epichordal.* The *basiventralia* are suppressed ; examples of this can be found in *Xenopus, Bombinator*, etc.

(ii) *Perichordal.* The *basiventralia* take part in the formation of the centrum as in the trunk vertebræ of common frog.

(*c*) *Gastrocentrous.*—Here the *basidorsalia, interventralia* and *basiventralia* are present. But the centrum is formed mainly from the *interventralia*, as in *Amniota* (Fig. 1).

If the theory of gradual evolution be held as true, such a wide range of diversity in the formation of the vertebral centra as outlined above by Gadow is rather difficult to correlate and explain, specially when it is well known that there is nothing more rigid and non-plastic than the skeletal system in the animal kingdom, and as the origin of this structure in the animal kingdom by mutation is problematic.

Prof. Mookerjee in studying the modes of development of the centra of the vertebral column has taken a series of microscopical sections of numerous fishes, frogs, lizards, snakes, tortoises, birds, moles, etc. He has shown that the centra in different classes have not been evolved independent of each other, as suggested in the various theories put forth by the previous authors, but that all the vertebrates have followed the same course of development, and exhibit a gradual evolution from one end of the series to the other.

According to Prof. Mookerjee, in all vertebrata, after the formation of notochord and its sheaths the skeletogenous cells aggregate round the notochordal sheaths, forming an outer jacket known as the perichordal tube. In all the vertebrates, except in Elasmobranch, the perichordal tube alone gives rise to the formation of the centrum. In Elasmobranch the centrum is formed by the chondrification of the inner sheath with the help of migratory skeletogenous cells that form the perichordal tube. These cells get inside the inner sheath by penetrating the outer sheaths at the base of each arch.

Starting from Teleosts right up to Mammals, it is the perichordal tube that is converted into a bony ring distinct from the notochordal sheaths forming the vertebral centrum. In *Anamnia*, however, Herring forms an exception inasmuch as both the sheath and the perichordal tube ossify. In *Amniota* the perichordal tube in the vertebral region is converted primarily into an inner and an outer ring.

Although the majority of vertebrates conform to the linear series with regard to the centrum formation, such types as *Amia* among Teleostomi, *Amblystoma* among Urodela, *Bombinator* and *Xenopus* among Anura, show deviations from this fundamental ground plan, as a result of adaptation to changed conditions of life (Fig. 2).

The neural arch in Urodela is composed of a pair of cartilaginous arches, called *basidorsalia*, and a dorsomedian plate, called *supradorsal*. These arch elements are present in almost all the

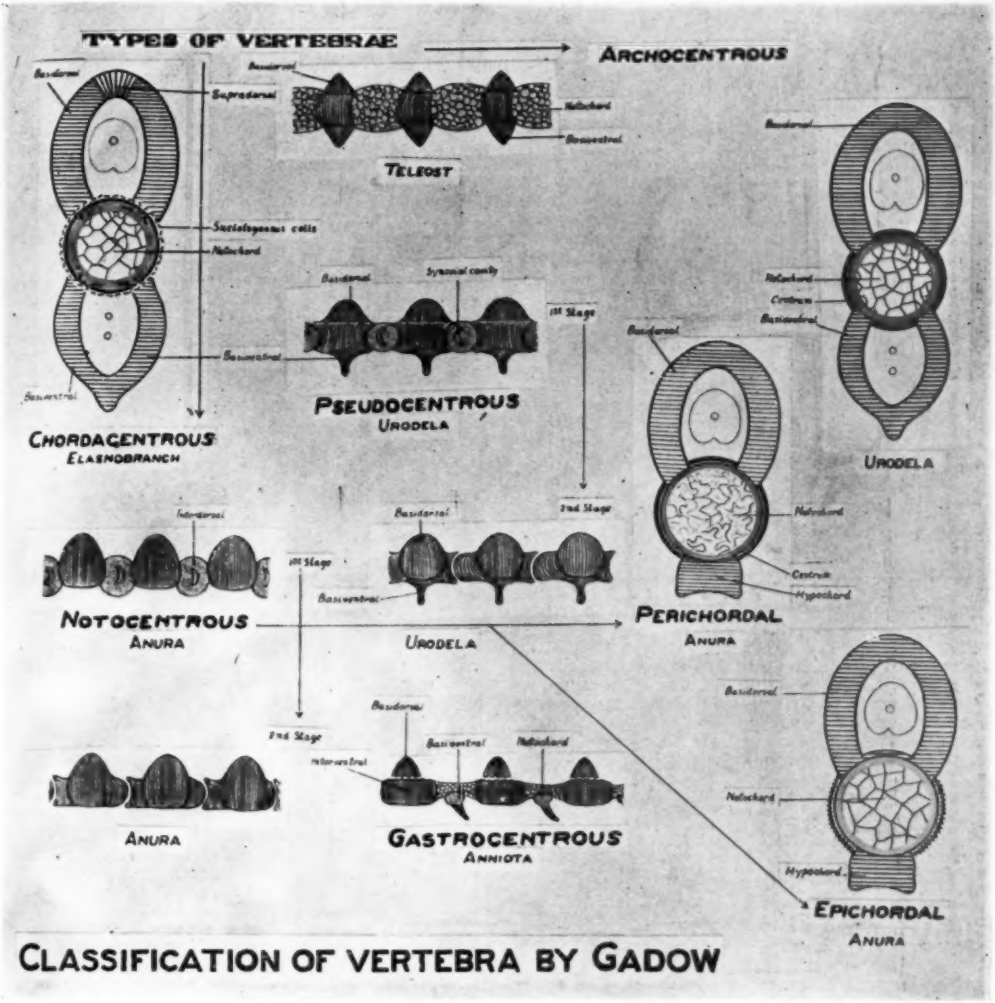


Fig. 1.

vertebrate series. Thoracic and caudal vertebræ of Chelonia, as well as the different vertebræ of Lacertilia, Ophidia, Crocodilia, Aves and Mammalia retain the Urodelan condition. The cervical vertebræ of Chelonia as well as vertebræ of Teleost and Anura, however, differ from the above series in having no distinct *supradorsal*; while some Teleost, *viz.*, *Haddock*, is peculiar in having the basidorsal arch as membrane bone.

In the cervical and caudal vertebræ of Chelonia as well as in the vertebræ of Urodela and Ophidia, two additional arches are found associated with each centrum. Both these arches are, in the beginning, composed of connective tissues which ultimately become membrane bond without passing through the stage of chondrification; one of them is placed anterior and the other posterior to the basidorsal. At a later stage, owing to ossification and fusion, these three separate arch elements lose their distinctness; therefore, in an adult vertebra, a single neural arch appears to be present. The existence of these membrane bone arches was missed by the previous workers. Another point that was also overlooked by the previous workers is the degeneration of the cartilaginous cells which occur together with the inner perichondrial layer of the basidorsals of Urodela. By modification of the above condition

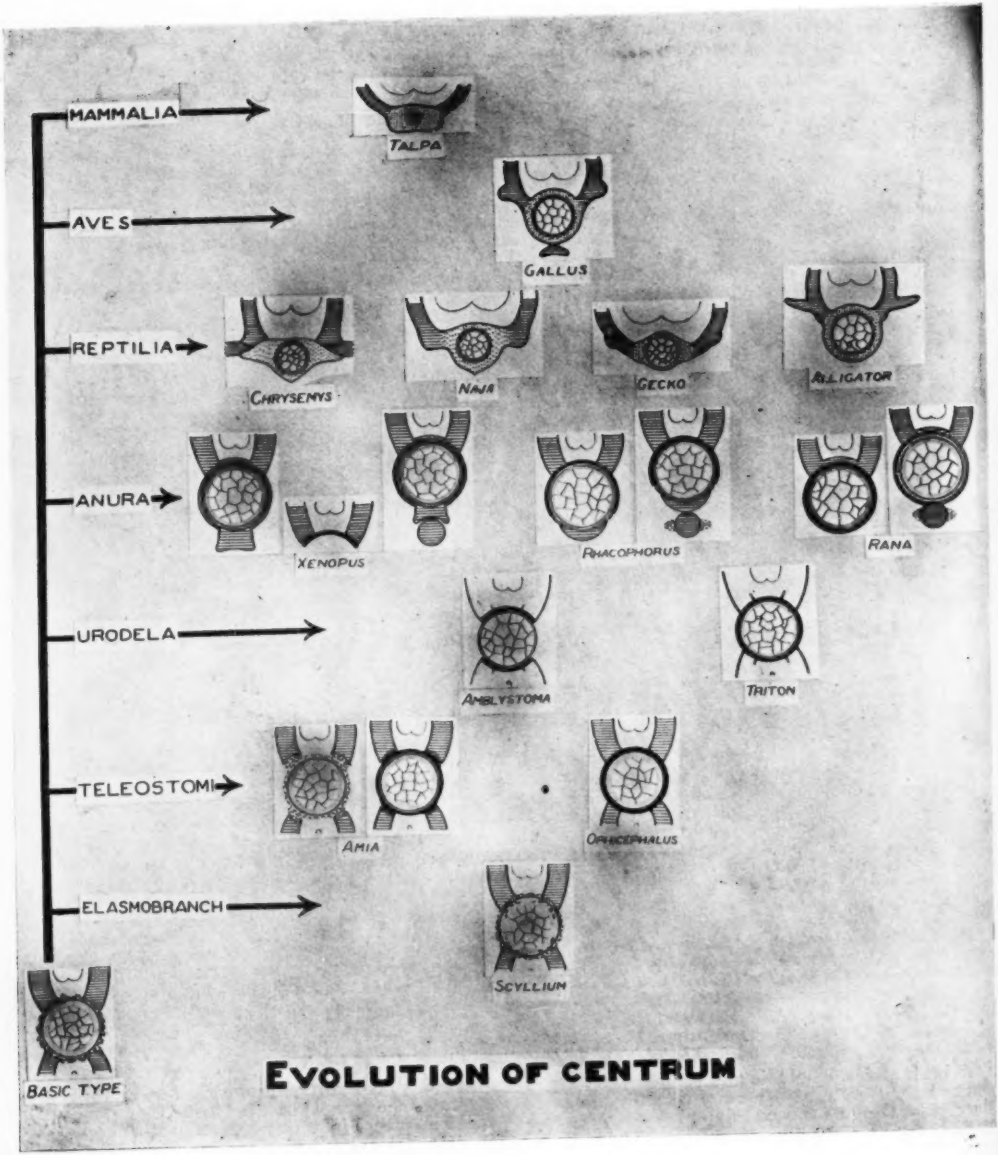


Fig. 2.

such as the addition of anterior and posterior membrane bone arches in Urodela, Ophidia, and in cervical and caudal vertebræ of Chelonia, or by their displacement, as in the thoracic vertebra of Chelonia, the seemingly diverse types of the neural arch have been evolved. The dorsal spine in all cases, except the thoracic vertebra of Chelonia, is formed from the mid-dorsal roof of either the anterior connective tissue arch or from the supradorsal.

With regard to the lower arch of the vertebra, it may be said that this arch is composed like the basidorsal, of a pair of basiventralia and a median infraventral piece. This typical condition

is found generally in the caudal vertebræ of Urodela, Reptilia and Mammalia. Considerable modifications of this typical condition occur in different groups and also in different regions of the vertebral column. In the trunk region of the Elasmobranch and some of the Teleosts, a pair of basiventralia exist as divaricated transverse rods. In Urodela, the rods are very thin and membraneous, except in *Necturus* where they are cartilaginous. The basiventral element persists in the membraneous condition throughout life, but the previous workers have erroneously stated that the basiventral element fuses with the other elements to form the centrum as in Aves and Mammalia. In some cases the basiventral elements of either side fuse into one piece to form, either the intercentrum as in Lacertilia, Ophidia, and Aves, or the hypochordal structure as in Teleost and in the Urostyle region of Anura. The ventral arcualia are similar in composition to the dorsal arcualia in being made up of two membrane bone elements in addition to the cartilaginous arch. The basiventralia also degenerate like the basidorsals in Urodela and here also there are spinous processes on the midventral surface of the anterior connective tissue arches. Thus, however diverse, apparently, the vertebral arches may seem to be, all of them can be derived from the Elasmobranch type with some additional structures to protect the caudal blood-vessels efficiently.

The transverse processes or diapophyses, are present in the vertebrate series from Amphibia to Mammalia. The position of the diapophysis varies in the different classes and in some cases varies even in a particular genus.

The rib, in all cases, starts its development within the lateral myotomes away from the vertebra and is subsequently articulated with the diapophysis. In such ribs as have two facets, one of the facets, *viz.*, the tuberculumn, articulates with the diapophysis, and the other facet, capitulumn, articulates either with the parapophysis, or with the membraneous basidorsal element, as in the case of Aves and Mammalia. In the adult condition, this membraneous basiventral loses its identity in a dried skeleton and we find that the capitulumn articulates with the body of the vertebra.

In some Anura, such as *Xenopus* and *Bombinator*, and in some Reptilia such as *Gecko verticillatus* and *Tropidonotus stolatus* or *Naja naja*, some of the caudal ribs are articulated with the diapophyses in the larval stage, but in the adult stage these are fused with diapophyses, thus producing a long massive structure seemingly like diapophysis, the identity of the ribs being lost due to fusion.

Successive vertebræ were yoked together in the embryonic stage by longitudinal processes that were cut into two halves by a strand of migratory connective tissue cells so as to produce the articular facets. The migratory connective tissue cells also divide the originally continuous perichordal tubes into vertebral segments, and the direction followed by these cells determines whether the centrum is to be of procœlous, opisthocœlous, or amphicœlous type. The course adopted by the migratory cells was influenced by the movement of the embryos. The synovial cavity originates by the splitting and separation of the split halves of the strand of migratory cells.

The developmental history of the vertebral column, as revealed by the study of comparative embryology, is full of significance, inasmuch as it shows a kind of uniformity in the processes of growth and differentiation and gives a glimpse into the mode of origin, formation, and modification, of a morphological character which has an important bearing on the evolutionary history of the vertebrates. The results of embryological studies are of great value to the evolutionist. They probe deeper into the mysteries of life and open new fields of investigation bordering on the realm of experimental studies on the embryonic life of animals.

ANTHROPOLOGY.

President : MR. H. C. CHAKLADAR, M.A.

PROBLEMS OF RACIAL CLASSIFICATION OF THE INDIAN PEOPLES.

IN India racial classification has so long proceeded on very scanty anthropometric data, and hence it has been quite unsatisfactory. Risley initiated anthropomorphic measurements in India, but the data obtained by him supplemented by those collected by others, are quite inadequate for such a vast country as India, especially as the Indian peoples are divided into innumerable independent groups that do not intermarry. Risley's classification of the Indian peoples, based upon this inadequate material, into seven racial types, has rightly been rejected by anthropologists. Risley gave, for example, the racial designation of *Mongolo-Dravidian* to the peoples of Bengal and Orissa, though they are not marked by Mongoloid features at all. Then again, Risley's Dravidians fall at least into four racial types : (1) the dark, long-headed, wide-nosed type which has been given the unsatisfactory designation of *Pre-Dravidian* by some and which has been called *Proto-Australoid* by Dr. Hutton in the last *Census Report of India* although craniological measurements have shown clearly that the theory of a common racial stock for the jungle tribes of the Deccan and the aborigines of Australia is quite untenable ; this type had better be called simply *Veddaic* ; Hutton's theory of its migration from Asia Minor is also disproved by the great difference in the nasal index between the ancient Mesopotamian and Indian skulls ; (2) the Munda-Kol group of Chota Nagpur which possesses considerable affinity with the former, but has points of difference also ; (3) the long-headed, fine-nosed type, speaking Dravidian languages who, on account of their Mediterranean affinity, had best be called *Indo-Mediterranean*, independently of any reference to the language they speak ; (4) and lastly, the round-headed, fine-nosed type with Alpine affinity which claims numerous individuals amongst the Dravidian-speakers. The two latter types are not peculiar to the Dravidian-speaking area alone, but are of a much wider distribution in India. Intensive anthropometric work involving 60 measurements and 31 somatoscopic observations on each individual among the people of Bengal by the author, shows the presence, both among the high castes, such as the

Radhi Brahmins, as well as the low castes like the Muchis, of a predominant round-headed type, and also of an appreciable number of the Indo-Mediterranean type, this latter type being more numerous among the lower castes than among the higher. Anthropometric investigations in other parts of India would probably show a very wide distribution of these two types. Both of them are represented in the skulls excavated at Mohenjo Daro, and they appear to have been the earliest importers of advanced civilisation and culture into India.

The speakers of Aryan languages are represented by two groups in India, one, the round-headed type with Alpine affinity mentioned above, and the other, a tall and long-headed type which has been called *Proto-Nordic*, and the dialects spoken by two groups belong to two distinct branches of the same Aryan tongue. The present distribution of the round-heads in India in the marginal areas in the west, south and east, as also their presence at Adichanallur, shows that they must have entered the country earlier than the *Proto-Nordics*. As such they must have initiated the Vedic culture in India which the tall, long-heads, arriving later, absorbed from them. The Vedic culture was carried, even in the Rigvedic age, by the long-haired, brown-robed *Munis*—pioneer missionaries of the Vedic religion—over a great part of India, from the Western to the Eastern Ocean, as the *Rigveda* (X, 136) puts it. The Brahmana portion of the Vedas speak of mighty empires established by the Vedic Aryans in eastern India. The charge of impurity brought against the peoples of Sind, Gujerat and Konkan in the west and Bengal and Orissa in the east, belongs to a much later literature, and is due to their trade and intercourse with foreigners by land and sea; this the purists in the midland where the later Vedic literature flourished, condemned in severe terms, and prescribed the most distressful penances for them; in the midland itself, the people were getting fossilised in their habits and customs, with a narrow outlook towards life, and they began to think that the habitation of the pure Aryans was confined within very narrow limits,—between the Ganges and the Jumna. But the presence of tribes at a low stage of culture, but resembling the Indo-Aryans in their physical features over the wild area from the borders of Assam to the hills of Annam, amply proves that people with Indo-European features had traversed the whole of northern India from the western gates to the eastern frontier, and passed through the forests and hills beyond, even up to the Pacific, in very early times.

No sound and definite conclusions, however, about the racial composition of the Indian peoples, are possible without further anthropological material, and therefore extensive measurements should be taken in all parts of India, preferably by local investigators with an efficient training in anthropological method, and possessing a knowledge of the language of the people among whom they work. In England, an appeal has recently been issued "to set on foot a comprehensive survey of the past and present populations of Great Britain": the need for such a movement in India is much more urgent, as the anthropological work so far done is of the nature of a preliminary survey only.

AGRICULTURE.

President: MR. A. K. YEGNA NARAYAN AIYER, M.A. (Mad.), DIP. IN AGRIC. (Cantab.), N.D.D., F.C.S.

SOME ASPECTS OF SCIENTIFIC RESEARCH AS APPLIED TO INDIAN AGRICULTURE.

ONE of the peculiar features of agricultural research has been the test by which its success is generally measured, *viz.*, the extent to which results of immediate practical value and application are attained and adopted by the agriculturists of the country. A policy therefore which will combine the need of attaining such quick and practical results without at the same time sacrificing the accuracy and reliability that experiments conducted over a long series of years alone can guarantee has to be adopted, which restricts considerably both the kind of subjects that could be taken up and the manner in which it could be pursued. The test, however, is bound to become more severe as the years go by under the new form of Government. But the record of the past 25 years is one of signal success both for research and propaganda more than justifying the expenditure on the various Departments of Agriculture and certainly encourages us to hope that in the future as in the past agricultural research can fully meet the test. The instance of Mysore is given in illustration, where improvements have taken place on an extensive scale. Improved ploughs, threshing appliances, sugarcane mills, and pumping installations have largely displaced the traditional methods. Oilcakes and artificial manures have come into general use; new crops, new and improved varieties of groundnuts, ragi, paddy, cotton, sugarcane are grown on thousands of acres; spraying against arecanut and coffee disease has been extensively taken up; the prickly pear has been exterminated, inoculation of cattle against diseases made thoroughly popular; serum and vaccines are manufactured locally and mortality from the deadly disease "Rinderpest" effectively kept down. (The address gives a full description of these interesting developments.)

Encouraging as these results are, progress can be greatly speeded up if profitable and ready markets for produce can be assured preferably by means of local manufacturing industries which will furnish an outlet for these crops. This is strikingly demonstrated by the improvements which have taken place in the cultivation of sugarcane for the new factory at Mandya in the Mysore State, where the use of improved ploughs, artificial manures, growing of improved varieties of sugarcane and its cultivation by special methods have all come into vogue within less than a year in contrast with the period of several years which they have taken elsewhere in the absence of such stimulus. A measure of all-round prosperity has also been ushered in as the result of this ready outlet for all the cane grown by the ryots which augurs well for other improvements. The development of the cultivation of Cigarette Tobacco in the Madras Presidency has led to similar results in that part of the country, as likewise the making of casein for the dairy farmers in parts of Bombay. The organisation of special Committees on the lines of the Indian Central Cotton Committee which will comprise growers,

scientific workers, manufacturers, and traders in respect of each important crop or group of crops in India, is likely to lead efficiently not only to a solution of the many problems of crop improvement, but also to an exploration of their commercial utilisation by local manufacturing industries and to the kinds of progress illustrated by the sugar industry described above.

The sugar industry has brought into prominence the question of the utilisation of molasses in a manner profitable to the industry and beneficial to agriculture. The manufacture of alcohol of all grades including absolute alcohol for use for various industrial purposes offers great promise and Mysore has already made a beginning which is worthy of all the support which the Government can give. Among its other uses, the making of cattle feed mixtures offers almost unlimited scope and will meet one of the crying needs of Indian Agriculture. Experiments in the making of products like molascuite with the addition of begasse dust, groundnut shells and haulms or shredded straw are suggested as promising methods of utilisation. The work now in progress for utilising it as manure will have to be continued for several seasons more to eliminate practical difficulties in the application and to make the results more definite and conclusive.

The utilisation of the bye-products which are at present mere waste products in respect of other crops also is a subject which needs greater attention, if only as a means of making the cultivation of these crops more profitable, leaving aside the question of industrial advantages. Arecanut husks, plantain stems, groundnut husks, paddy husk, cotton stalk, coffee pulp, are some of the materials that come in this category and the methods of one kind or another which have from time to time been suggested may with advantage be examined and work on alternative methods also undertaken for investigation.

The subject of "*quality*" in crops and the possibility of improving it by methods of manuring is one of great importance and deserves to be taken up without further delay. So far all manurial experiments have had for their object only an increase in the quantity of the produce concerned and little or no attention has been paid to the effect on the composition of the commodity. Many factors to which the economic value of a crop is due such as the sugar in sugarcanes, oil content in oilseeds, starch in potato, the burning quality and nicotine content in tobacco, staple in cotton, quality in rice, protein in wheat, keeping quality in fruits, etc., are already known in a general way to be affected by the soil constituents and manuring, but the matter has not so far formed the subject of serious investigation. What really constitutes quality in many crops like rice and coffee for example and to what constituent or constituents such quality is due will have also to be gone into as a preliminary, but in respect of sugar, starch, oil, proteins and known essential principles to which the other crops mentioned owe their quality, this difficulty does not exist and the problem is less complicated. So far, the performance at the weigh-bridge alone has been the test of the action of the manures and judged by this test many a manurial experiment has yielded results either contradictory or inconclusive. It is not at all unlikely that if attention should be directed to the composition of the crop as well these experiments will tell a different and a very valuable tale.

Such exclusive importance attached to the quantity alone with no regard paid to quality or other reactions of the crop leads also to the one-sided manuring now becoming common with its dangers to the permanent fertility of the soil; for in the large majority of Indian soils nitrogenous manures alone produce satisfactory increase in the yield, phosphates and potash giving either very little increase or none at all.

The effect of soil constituents sometimes called catalysts including even the rare elements is also worthy of study as in addition to their reported increase of yields it is possible that connection may be traced between them and some of the baffilling plant diseases put down now to physiological disturbances, viruses and so on, much in the manner of the subtle effect of vitamins in the animal body. As a practical need of immediate importance is a strengthening of the staff for the investigation of plant diseases and pests and increased attention devoted to their investigation. The loss due to these in the aggregate is stupendous and for most of them cheap and simple remedies are extraordinarily difficult to suggest. Many indeed are the most baffling and the problem is really one for more than one branch of science. A many-sided attack from the Mycological, Entomological, Chemical, Botanical and Agronomic sides has to be organised in regard to these with provision for proper co-ordination and co-operation. Among pests that have assumed special importance recently is the borer pest on sugarcane which is a serious menace to the sugar industry. A large-scale campaign of parasitic control is indicated as about the most feasible while the action of light of different kinds, or irradiation and the newly-patented Entoray light traps need to be tested extensively.

As an allied subject, the problem of weed control may be referred to, special mention being made of the "touch-me-not" pest in the Mysore Malnad which is over-running the tract to the despair and dismay of the people and where some kind of biological control as in the case of the prickly pear alone appears to be likely to meet the situation.

In the field of cattle improvement work has been somewhat halting and tentative owing to the conflict of views regarding methods, whether it should be by crossing with foreign breeds or by selection from local breeds. Matters such as adequate fodder supplies and their conservation, and the problem of the dead load of useless cattle have added to the difficulties. But, on the other hand, we are bringing diseases under control, popularising the castration of scrub bulls and the keeping of proper stud bulls and are thus removing some of the old obstacles; while the large demand for milk due to the growth of cities is acting as a powerful stimulus to cattle improvement. Conditions are thus favourable for some marked progress in the near future.

Among the many economic factors which set effective limits to the spread of improvements is the lack of proper marketing organisations. The creation of the new department for Agricultural Marketing is therefore welcomed as a powerful ally to the scientific worker in his

attempts to increase the profits of farming. Lines of work which will benefit the country as a whole, both grower and merchant alike, as the result of the present marketing surveys are indicated. The opinion that science has led to over-production and the present depression in agriculture is strongly controverted. As long as there are millions of people who though able and willing to work have still to remain ill-fed and ill-clad, it is useless to talk of overproduction or superfluity. What Indian agriculture wants on the other hand is science and still more science to rescue it from the ills that beset it on all sides.

MEDICAL AND VETERINARY RESEARCH.

President: LT.-COL. H. E. SHORTT, I.M.S.

IMMUNITY IN PROTOZOAL DISEASE.

THE subject of Immunity in Protozoal Diseases was chosen because of its interest for a Medical Practitioner, Veterinarian and Biologists. Immunity is defined as the result of the two opposing forces of the invading parasites and of the invaded hosts. It was formerly held that the mechanism of immunity in protozoal diseases differed from that of bacterial diseases. It is, however, now believed from evidence available that the mechanism does not, in any manner, differ appreciably in bacterial and protozoal infections. Foreign substances acting as stimulants are called antigens and the resulting specific substances which react with them are called antibodies : it is almost certain that all substances which are complete antigen are protein in nature. The phenomena, which occur when antigen and anti-bodies are brought together, are agglutination, lysis, precipitation, complement fixation, phagocytosis in the presence of opsonins and bacterio-tropins. The theoretical concept which explains these reactions is the classical theory of Ehrlich, *viz.*, the side chain theory; while this theory has undergone modification it forms a good working hypothesis. These various reactions, agglutination, etc., are probably the result of one and the same anti-body performing different functions. The union of antigen and anti-body takes the form of an aggregation of globulin particles around the antigen. The result of this union at the surface of cell, sensitises it equally to Lysis, to complement and fixation, to phagocytosis by leucocytes and flocculation by electrolytes, each phenomenon depending upon various factors.

Trypanosomes are suitable protozoa for the study of such immunity reactions. They multiply by binary fission. If they are injected into a susceptible animal, the multiplication will be by geometrical progression. The most accurate method of determining whether such immunity is operative is to make a curve of the parasites in blood which can be denoted by the equation $X = R - D$ where X is the number of parasites at any specific time, R the number produced by division, D number destroyed. If a white mouse is inoculated with a pathogenic Trypanosome such as *T. rhodesiense* and the events followed, it will be found, that after the incubation period of 4 days, there is a continual increase of trypanosomes showing that the host exhibits no immunity response whatever. If, however, the same parasite is injected into a guinea-pig, after the usual incubation period there is an increase of parasites and a decrease in the number of parasites alternately till the animal dies. There is probably a rapid destruction of parasites during what are called the crises, these crises happening over and over again. The mouse exhibited no immunity. The guinea-pig was more successful and it stood the infection for some time. If we can imagine an animal a little more resistant than the guinea-pig, we arrive at a working arrangement between host and parasite in which the host supplies a habitat to the parasite and the latter makes a minimum of demand on the vitality of the former. Trypanosomes can be considered destroyed in guinea-pig by what may be called trypanolysin. The few parasites which resist trypanolysin have become biologically altered giving a relapse strain resistant to trypanolysin. If a non-pathogenic trypanosome, *viz.*, *T. lewisi* is injected into a mouse, there is an incubation period followed by multiplication and crises in which a large number of trypanosomes are destroyed, later re-multiplication, a second crisis in which all the parasites are destroyed. The mouse is now immune to infection. There is here probably reproduction-inhibiting mechanism in addition to the lysin. Other parasiticidal mechanisms are, phagocytosis and alterations in the level of blood sugar.

In malaria, the immunity reaction mechanism is probably very similar to those already explained. Most of the work has been done on Bird Malaria. The parasite in Bird Malaria has a sexual and an asexual cycle, and it is only with the latter that we need deal. There is the usual incubation period after the infection, when probably there is no immunity response. There is then the period of acute attack in which multiplication of the parasites occurs in geometrical progression. Crises follow, and there is destruction of the parasites, not due to any retardation of the rate of reproduction, but possibly due to (i) the natural unsuitability of the Bird for the parasites, (ii) phagocytosis, and (iii) perhaps decrease in the level of blood sugar. In Malaria, there is a latent period after which a relapse may occur. The theories which explain the latent period are various. Parthenogenesis, specialised resistant asexual forms, are such theories. The balance of evidence is, however, in favour of asexual reproduction at a low level during latent period. The immunity is only present while the host still contains living parasites. The difference in malaria and trypanosomiasis is, in the former there is a temporary suspension of the parasiticidal mechanism, whereas in the latter there is a development of a resistant form of trypanosomes. Experiments on mammalian malaria can be conducted on Monkeys which are quite suitable. Complement fixation tests and precipitin tests have been conducted on malarial sera with various antigens; some workers claim a good deal of success with such tests. Phagocytosis is perhaps not the primary agent in mammalian malaria. There is also a change in the electrical charge of the red blood-cells in Bird Malaria, inversely proportional to the parasite count, an important factor in inducing the phagocytosis.

In Leishmaniasis, both visceral and dermal, there is no reason to suppose that the difference in the mechanism is in any way different from the other protozoal diseases. In *Kala-azar* the reduction in electric charge is very great

indeed. In Piroplasmosis (containing the families of *Babesiidæ* and *Theileriidæ* which are of great importance affecting cattles, horses, and dogs) the same phenomena as in avian malaria are met with, there being a minimum number of parasites, during the latent period in the blood of the animal, the animals can at this period be rendered immune by drugs. This immunity is not complete, as another strain of the same parasite will reproduce all the phenomena of infection.

In this discussion, we deal with the biological interactions, only a part of which is within our knowledge and under our control. Practically therefore, we are attempting to solve the equations many of the factors of which are unknown. The mechanism at work is probably similar to, if not identical with, those found in bacterial diseases. In Virus infections and in some Bacterial diseases, life-long immunity may be obtained, but in protozoal infection one may be immune to one strain, but not to another strain of the same parasite. Historically this may be explained as due to non-migratory habits of ancient animals and host-parasite interactions giving immunity to the local strain only. Another point is that immunity lasts as long as there is a regional infection.

PHYSIOLOGY.

President: DR. W. BURRIDGE, D.M., M.A., F.N.I.

SOME FUTURE LINES OF ADVANCE IN PHYSIOLOGY AND MEDICINE.

PHYSIOLOGISTS at one time primarily concerned themselves with the muscle-nerve preparation of the frog, and as a result built up a science yet current which is founded on three basic hypotheses. The three are: (1) that natural stimulation, such as that of the eye by light, is a process precisely similar to that of exciting an isolated and quiescent muscle or nerve to activity by electric currents, (2) that all organs of the body remain as quiescent as do isolated muscle or nerve until excited to activity by an agent, usually external, called the stimulus, (3) that the process of stimulation depends on the explosive decomposition of unstable colloidal complexes, called excitable substances, through the shock or commotion conveyed to them by the passage of electric currents.

These three theories, either individually or severally, have been regularly treated as facts for the purpose of forming other theories or explanations of how any organ of the body behaves. The validity of the established science thus depends on the validity of these basic hypotheses none of which was ever the subject of formal scientific proof. They are instead presumptions used as working hypotheses, and they have been worked so long that they have now become the physiologist's equivalent of the theologian's article of faith. Any doubt of them is physiological heresy.

Their truth could not be challenged so long as physiologists neither knew the laws which govern the stimulation of rhythmically active tissues nor the modes of behaviour of the same tissues when they were stimulated to greater activity. The evidence of fact filling these gaps is now available. It demonstrates that the process of stimulating a rhythmically active tissue to greater activity is entirely different from that of exciting an isolated muscle or nerve to activity by electric currents. No suspicion of such differences was in our philosophy, yet the former type of stimulation is undoubtedly natural because it occurs within the living body. Wherever also natural stimulation can be examined, it follows the laws that govern the stimulation of rhythmically active organs.

The new facts available now leave no reasonable doubt that physiologists in their experiments have often stimulated rhythmically active organs to greater activity, but without being able to recognise what they were doing because of lack of knowledge both of the laws governing this stimulation as well as of the behaviour appropriate to it. They further did these experiments in the firm belief that they were exciting quiescent tissues to any activity at all. There was never, however, concordance between what ought to be, if the primary hypotheses were true, and the actual findings. These discordances were adjusted by special secondary hypotheses, and no alternative to this course was available so long as there was no suspicion of any alternative primary hypotheses. The new knowledge of rhythmical tissues demonstrates in consequence that much of what has hitherto been regarded as sound science is really an adaptation of facts to original false presumptions. This is especially the case with the explanations of physiology concerning the nature of the activities of the central nervous system. Physiology here is at least a generation behind the New Psychology and is destined to remain static until it appreciates the fact that a tissue in an active state acquires through its activity properties which are not present in tissues in the state of rest.

A change in the composition of blood or lymph, though it may be called a change of internal environment, implies much more than does a change of external environment inasmuch as it implies a change in the chemical composition of the dispersing media of the colloidal systems constituting the living cells which those fluids bathe, as well as those of the bathing fluids themselves. Any consideration of such changes therefore which entirely ignores the existence of colloidal systems must be essentially incomplete. It is the exception rather than the rule, however, to find what are called changes of internal environment considered in terms of the properties of colloidal systems.

Numerous experiments demonstrate that many substances affect the properties of living tissues by exactly those two modes which are predictable if those properties were dependent on processes taking place in colloidal systems. The same experiments demonstrate that in the adsorption processes and in the state of aggregation of their colloids living tissues possess two sources of energy for their activities, whereas the traditional presumption has been that they could only possess one. The two sources of energy are moreover so independent that the capacities of the tissue can be augmented through the one at the same time that they are decreased through the other. The basic hypothesis which presumes one sole source of energy makes the facts inconceivable since it requires one to imagine something being both up and down at one and the same time.

Alcohol is an interesting drug which exerts two opposite actions which are readily understood when one realises that every organ has two sources of energy for the drug to act on. In contrast with this case of understanding the presumption that an organ can only possess one source of energy provides a number of insoluble puzzles for apparent solution. The social importance of the drug has further determined the development round it of a special but pseudo-science which attempts to explain what is actually inexplicable so long as one holds fast to the faith that living tissues can only possess one source of energy for their activities.

The two sources of energy have been called the kinesiphores and the uncontrolled experiments which men perform on themselves with alcohol can now be used to throw light on the part played by each kinesiphore in our mental activities. The donation to nerve cells of two sources of energy, where previously one had been presupposed, *plus* the donation to them of inherent rhythmical activity instead of inherent quiescence provides possibilities beyond previous dreams. The knowledge that a nervous path consists of a number of relays normally attuned but on each of which alcohol can differently act enables the user of a wireless set to appreciate more about the inco-ordination of drunkenness than what the best science could hitherto have taught.

PSYCHOLOGY.

President: J. M. SEN, M.Ed. (Leeds), B.Sc., F.R.G.S., F.N.I.

MEASUREMENT IN EDUCATION.

IN all problems of education two things are important: (1) the child with his given potentialities and limitations which we may call *heredity*, and (2) the *environment* (physical, nutritional, social and ideational), in which the child grows. Education is a function of these two *variables*, although no precise formula governing their relationship is yet available.

The child begins life as a field for the operation of two forces—heredity and environment—which may often work in harmony, but sometimes in opposition. The child does not grow by spontaneous unfoldment. Growth is a continuous process of assimilation, a taking possession of an ever widening environment, a ceaseless redistribution of energies flowing into the organism from the universe around.

For the teacher the problems of heredity often assume the spurious garb of the inheritance of acquired characteristics. Many teachers are liable to the fallacy of apparent transmission of acquired habits, whereas the general trend of evidence is in favour of the transmission of *educability*, which is a very different thing from the direct transmission of the *results of education*. All that the practical teacher can attempt to do is to make the best of the hereditary potentialities of every child placed in his care by a suitable manipulation of the child's environment. To discharge this responsibility aright, he has to acquaint himself with the technique of the measurement of "Intelligence". With the introduction of compulsory Elementary Education in some of the Provinces and States of India, the problem of weeding out the pupils who are unfit for Secondary Education, is assuming gigantic proportions. An efficient process of classification is rendered possible by the application of educational tests. If educational tests suitable for Indian conditions are devised, and applied at several stages in the career of each pupil, collossal waste in educational expenditure and effort could be avoided.

Current examination methods of classifying pupils are still labouring under serious defects such as the *personal equation* of the examiner. The finer aspects of the results of education are apt to be missed by the crude procedures employed by the examiners—which are still far too detailed and factual. The current system of examinations does not make for *thinkers*, but for plodders; it does not foster an equiting alert mind, but a dogmatic retentive mind. In place of a live wire our schools produce a blotting pad. They can take faithful impressions, but cannot provide the dynamic force which makes for creative activity.

These evils of present-day education which are bound up with our system of examinations, cannot be rectified, until the teacher takes up seriously the task of standardising suitable tests of intelligence, character, and of achievement in school subjects. The task is gigantic, but I feel sure that the teachers will rise equal to the occasion.

Discussions held at the Congress.

1. **The Making of Humus and its Applications.** (*Agriculture and Medical Sections.*)
2. **The Problem of Nutrition in India.** (*Medical and Physiology Sections.*)
3. **The Teaching of Biology in Schools.** (*Botany and Zoology Sections.*)
4. **The Scope of Preparations of Fine Chemicals in India.** (*Chemistry Section.*)
5. **The Utilisation of Molasses.** (*Chemistry Section.*)
6. **The Classification of Archæan Rocks of India.** (*Geology Section.*)
7. **The "*Myxophyceæ*", "Saltation in artificial cultures of fungi", "The Standardisation of Vernacular names of Indian Plants", "Chromosome Morphology and polyploidy" and "The importance of anatomy and toxonomy".** (*Botany Section.*)

Spectroscopy: Its Applications.

(Sifting the Secrets of the Universe by the Analysis of Light.)

By Everett White Melson.

(*Bausch & Lomb Optical Company, Rochester, N.Y.*)

MORE than two hundred and sixty years have passed since Newton discovered that a beam of light could be separated by means of a prism into bands of violet, indigo, blue, green, yellow, orange and red. This was the beginning of a series of experiments that have supplied more information about the nature of the physical world than any other single phase of research. Whether the constitution of a star, the earth or an atom is under investigation, the analysis of light plays a constantly increasing part.

This phenomena of the separation of light is the basis of spectroscopy which, beginning with the study of the solar spectrum, now reaches into the expanding fields of metallurgy, chemistry, physics, medicine and biology.

The dispersion of light is due to the varying refrangibilities of these different colours in passing through media of varying densities. In passing through a quartz prism, for instance, violet waves have less speed than red and consequently are more retarded, or refracted. Kirchoff and Bunsen developed the following conclusions relative to the three more important types of spectra. When light from an incandescent gas or vapour is examined by means of a prism, its spectrum is seen to consist of a number of bright lines, coloured images of a spectroscope slit, which are always the same for the same gas under the same conditions of temperature and pressure. Thus the spectrum of sodium vapour at the temperature of the Bunsen burner consists of a single pair of bright yellow lines corresponding to the Fraunhofer lines D_1 and D_2. Lithium gives a single line of deep red. Thallium light is green and strontium emits a blue light. The light from hydrogen, the prototype of all other spectra that originate in atoms, shows four well-marked lines, one in the red and one in the blue corresponding to the Fraunhofer lines C and F, and two fainter lines in the violet. Such a spectrum is known as a bright line spectrum. Its presence indicates that the source of light is a mass of incandescent gas or vapour under a pressure so low that the gas molecules have freedom of motion to execute whatever form of vibration they will.

When the light from an incandescent solid or liquid, or from a mass of incandescent gas under high pressure, is analysed, the spectrum is found to contain all colours from red to violet, showing no discontinuance at any point. This continuous, or band spectrum indicates that the source is an incandescent solid, liquid, or gas under high pressure. The spectra from molten metals, from the filaments of incandescent lamps or from the carbon tips of an arc lamp are all continuous spectra.

In 1814, Fraunhofer made a spectroscope and saw for the first time a pattern of many fine dark lines across the solar spectrum. In the spectra of the stars he observed these same dark lines. It was discovered that if a beam of white light is passed through a layer of gas or vapour before entering the spectroscope, this vapour will sift out and absorb precisely those light rays, or colour, which the gas or vapour would itself emit if incandescent. It is this absorption of light by gases which is so important in astronomic spectroscopy.

The absorption bands, whose relative positions were determined and lettered by Fraunhofer, afford a ready and accurate means of designating lights of definite colours. Many substances present characteristic absorption spectra. A piece of cobalt glass absorbs all colours, except a small strip in the red, and in the blue end of the spectrum. The absorption spectrum of chlorophyll shows a dense black line in the red, while blood, even if greatly diluted, shows two characteristic bands in the green.

Since the character of the light emitted by an incandescent gas depends first of all upon the vibrations of its constituent atoms, it follows that a study of the light emitted by a glowing gas affords direct testimony concerning its chemical composition. Consequently if the bright line spectrum of any substance is once known, whenever this spectrum presents itself, we may at once conclude that the given substance is present in the source of light, whether it is in a Geissler tube in the laboratory or from a fixed star in the vast depths of space.

The spectroscopic method of analysis is characterised by its ease and rapidity, and especially by its exceeding sensitivity. In the case of a Bunsen burner, 1/14,000,000 of a milligram of sodium is sufficient to show the characteristic sodium lines, while in the spark of an induction coil, 1/80,000,000 of a milligram of lithium may be detected. The extreme sensitiveness of the method has led to the discovery of numerous new elements which have been present in minute quantities as impurities in the substances under examination. They revealed themselves through characteristic new lines in the spectrum. Among the elements so discovered are cæsium, rubidium, thallium, indium and gallium.

The instrument with which this work is done is the spectroscope or spectrograph. Its operation is based on the dispersion of light. If sunlight is passed through three prisms having the same refracting angle, one of flint glass, one of crown glass, and one a hollow prism with plane glass sides and filled with water, the resulting spectra will be found to differ greatly in length. The spectrum from the flint-glass prism is about twice as long as that from the one of crown glass, and three times as long as that from the water prism. The various colours undergo widely different deviations through prisms of the same angle but of different substances.

A careful study of the dispersion of various refracting media is therefore a pre-requisite for the scientific construction of optical instruments. Since different glasses vary widely in relative dispersion, it is within the power of the optical glass maker to produce at will prism combinations that will give either deviation without

dispersion or dispersion without deviation, according as the need may arise. Basically all designs of the spectroscope consist essentially of four parts; the slit, the lenses, the dispersing system and the observing or recording system. Various optical and mechanical arrangements of these units are used, depending on the purpose for which the instrument is designed.

In the simple direct vision spectroscope a cemented prism of the Amici type is often used. This is composed of one flint unit and two crown-glass units, the angles and glass being so chosen that the F-line of hydrogen is undeviated. In the instruments designed for photography of the ultra-violet spectrum the sixty degree type of prism is usually employed, but in order to avoid image doubling, due to the birefringence of the material, it is composed of two thirty degree prisms, one of right quartz and one of left. The rotation produced in the first half of the prism is exactly neutralised by the reverse rotation in the second half. This type is called the Cornu prism.

If the instrument is designed for visual observation it is equipped with a cross-hair and eyepiece. If a permanent photographic record is desired, the eye-piece is replaced by a plate holder equipped with an operating mechanism. The last method is used almost exclusively in studies of the ultra-violet region, and in the case of the better visual spectroscopes the design is such that the telescope can be replaced by a camera. Certain inherent characteristics which depend on the design of the instrument determine its efficiency. Chief among these are dispersion and resolving power. To alter dispersion either the index or the angle of the prism must be altered; to alter resolving power the base of the prism must be changed, at the same time utilising its full aperture.

Perhaps the earliest and greatest use of the spectroscope until recently was in the province of astronomy. According to Dr. Edwin Hubble, of the Mount Wilson Observatory of the Carnegie Institution, the study of absorption spectra is the dominating feature of modern astronomy. "They furnish," says he, "an astonishing amount of information concerning the physical condition of stars and even of planets and nebulæ. Either directly or indirectly they indicate surface temperatures of stars, surface luminosities, total luminosities, distances, and velocities in the line of sight." The spectra of over 90 per cent. of all the stars are dark line absorption spectra.

It was the study of the spectra of distant nebulæ with the spectrograph which disclosed a peculiar characteristic to Dr. Hubble—the dark lines, or absorption bands, are not in their usual positions. The lines are all displaced toward the red end of the spectrum and the displacements increase with the faintness of the nebulæ observed. Observations are summed up in the statement that the fainter the nebula the larger the red-shift. Since apparent faintness of nebulæ is confidently interpreted in terms of distance, the conclusion is that red-shifts increase with distance. Precise investigations indicate that the relation is linear—red-shifts are equal to distances times a certain constant.

Many ways of producing such effects are known, but of them all only one will produce large red-shifts without introducing other effects which should be conspicuous but actually are absent. This one known permissible explanation interprets red-shifts as due to actual motion away from the observer. On this interpretation the nebulæ are rushing away from us, and the farther away they are, the faster they are travelling. The velocities increase roughly 100 miles per second for each million light years of distance.

It is by the accurate measurement of the colour of well-defined spectral lines that the astronomer is able to discover whether the body emitting them is approaching or receding, on somewhat the same principle that the noise emitted by an automobile horn sounds deeper in pitch when it is receding from us than when it is approaching. So the light from a receding body appears redder than that of one approaching.

Spectroscopy has become such an important study at the present time that international conferences are frequently held at which authorities report recent advances in numerous fields of investigation.

At a recent conference at Massachusetts Institute of Technology, one of the reports concerned one of the great riddles of medical science—the extreme complexity of the biological units which by their balance produce health or illness. One of these units, porphyrin, was shown by Dr. Calvin B. Coulter to be capable of analysis by the spectroscope with a sharpness, precision and simplicity which usually apply chiefly to the inorganic substances like the metals. Porphyrin is the base of red blood-cells. It is also the base of chlorophyll, the green colouring matter of plants, which they use to synthesise food through the agency of sunlight. The two porphyrins differ mainly in that the blood one is combined with iron while the green plant substance is combined with magnesium. Because of this, some scientists have speculated on the possibility that far back in evolution the green of the plants and the blood of man may have originated from the same source. This may be a link between plants and animals.

Coulter has found further evidence of this kinship of plants and men in porphyrin which he extracts from cytochrome, a pink pigment existing in the cells of virtually all those living things using oxygen. This cytochrome, he finds, is combined with magnesium, so that a porphyrin-magnesium combination is not an exclusive patent of the chlorophyll-green plants, but belongs also to the red-blooded races. This porphyrin, which he places under the light beams for spectral analysis, is obtained from bacteria. He dissolves it out of their cytochrome, which they use to obtain oxygen, somewhat as man uses his lungs to get oxygen. He studied this porphyrin when combined not only with its original magnesium, but also with copper, cobalt, nickel and tin.

At room temperature the spectroscope showed a general "curve" indicating the presence of porphyrin, but when Coulter cooled these porphyrins down to temperatures between 100 and 200 degrees below zero, the curves showed much more detail. They showed precision comparable with the spectroscopic curves which identify metals.

Spectroscopic investigation has also been of great assistance in the study of hæmoglobin, another vital body substance whose function is to transport oxygen from the lungs to various parts of the body. Dr. David Drabkin, of the University of Pennsylvania, has been able to carry out experiments far in advance of any of those previously made, and although the composition and structure of the plasma is still unknown, important work toward its solution has been done.

Just why nature has chosen a coloured pigment to carry oxygen, when there seem to be other substances which could do the job as well or better; why globin with its huge molecular weight of 68,000 is used to carry oxygen whose molecular weight of 32 seems insignificant in comparison; and how globin is attached to the other parts of the blood are problems science is anxious to solve. On the answers may hang some of the most valuable discoveries medicine has made concerning the human body.

And then there is the continuous search for a cure for cancer. Active in this is Prof. Ellice MacDonald, of the University of Pennsylvania, who has examined more than 10,000 liquids in an endeavour to find one that can be injected into a cancer to enhance the curing power of X-rays and radium. The liquid sought is one that will emit ultra-violet light of a specific wavelength when activated by X-rays or the gamma rays of radium. This secondary emanation is regarded as most important, but it is essential to have the radiation at the base of the cancer since it is almost impossible to transmit these rays any distance.

Incidentally, the most deadly radiation yet discovered, a narrow range of ultra-violet light, will destroy living cells almost instantaneously, according to Dr. MacDonald, who made these observations by means of a specially constructed quartz-microscope. In his search for the liquid which he believes will be of tremendous value in the treatment of cancer, Dr. MacDonald has discovered several which radiate the desired ultra-violet light. But the requirement that they be volatile and non-poisonous to human tissue has thus far proved a stumbling block.

The detection of cancer in its earliest stages is nearing through the discovery by Doctors A. J. Allen and E. B. Sanigar, that cancerous blood is different from that which is free of the disease. These new qualities of cancerous blood were discovered by means of the spectroscope in experiments on rats—and recently on human beings. While the work is admittedly in its early stages, it may suggest to other workers in this field a new and profitable method of investigation.

Some investigators have gone so far as the accurate forecasting of death by spectroscopic analysis of the blood of diseased persons. To the great astonishment of attending physicians in Paris, P. and M. Lecompte de Nouy, of the Pasteur Institute, predicted deaths by spectroscopic examination which occurred within 24 hours, although death was not believed imminent.

In their research more than 8,000 samples of the blood of men, horses and sheep were examined and various characteristics discovered by means of spectroscopic investigation of the serum and white plasma of the blood, which were plotted on charts. The resulting curves, similar to those on business trends, show a "remarkable constancy, so great that the curves can readily be superimposed on each other. The various fluctuations in the curves represent the various structural features of the blood as indicated by the various colours which manifest themselves by the absorption of light passed through the serum or plasma into the spectroscope."

When departures from this general trend are noted they can safely be interpreted as an indication of pathological disturbances. Such alterations must correspond to very deep chemical modifications affecting the chromophoric (colour) elements which belong to very stable chemical groups. Thus these changes in the blood show that very definite and basic chemical changes are occurring. These changes have been found for the most part to precede death.

It is also through spectrum analysis that marked progress toward the complete and positive identification of pepsin is expected. Although science has for years realised the importance and function of this important digestive juice, and has been fairly sure that it was composed of carbon, hydrogen, oxygen and other elements, just what amount of these substances constitute pepsin and how they are chemically arranged has remained a mystery.

Only recently, through the researches of Dr. Geo. I. Lavin, of the Rockefeller Institute, was it discovered that pepsin is a protein, but much additional information was needed. Now, Dr. Lavin's investigations with the spectroscope suggest that pepsin is constituted of amino-acids. His method was to compare the spectra of pepsin with those of substances of which it might be composed.

An equally fascinating phase of spectral study is the method of analysing the potency of vitamins by spectroscopic light. The eye of the spectroscope is so sensitive that it would take a pool of cod liver oil 300 feet deep to look the same as one paper-thin sheet of pure vitamin D, according to Dr. R. A. Morton.

For vitamin D, it appears, the spectroscope should not be used except with the pure vitamin, named calciferol, which is 40,000 times more potent than cod liver oil. This is because in the oil, or any substance containing vitamin D, colours which register only in ultra-violet light mask the lines which reveal the potency of the vitamin. Only biological tests with living animals are safe for testing the strength of vitamin D preparations.

But for vitamin A, the investigation shows, the spectroscope is the best method of analysis, exceeding even the biological tests. Further, the evidence of the spectroscope affords reason to believe that there is more than one kind of vitamin A. It indicates that there are probably several massive groupings of molecules, all very similar, each of them carrying the medicinal or physiological effects of vitamin A. With remarkable precision the spectroscope shows the existence of these apparently different groups, but they are so close together that there is at present no way of separating them to find out whether one group may be more potent than another.

At the University of Cambridge investigators have found that the fertility vitamin E absorbs

light in a distinct and characteristic fashion thus making positive identification possible. By dissolving vitmain E. prepared from wheat germ seeds, in aclohol, it was found that a sharp absorption occurs at a wave-length of 2900A. This wave-length is in the invisible ultra-violet region, near the actinic rays of light which cause sunburn. The key test in this research was to show that the vitamin E which produced this absorption really produced a biological effect when given to experimental animals. Such an effect was found, and according to Doctors Martin, Moore and Schmidt, "the vitamin caused a female rat which had shown characteristic resorption gestation to produce a litter of eight live young".

In none of the phases of spectrum analysis has more progress been made than in the examination of metals. Both in quantitative and qualitative spectrographic analysis the detection and identification of metals and alloys has shown the spectrograph to be the most sensitive instrument known, far outdistancing chemical analysis in speed and accuracy. This phase of spectrography alone is creating a new and exhaustive literature on the subject. Here, the purpose is to report the investigations that affect the lives of all of us more immediately.

And one of the most interesting reports comes from Prof. Jacob Cholak, of the University of Cincinnati, which describes the detection of lead in the human system. While qualitative determination has been possible for some time, exact quantitative measurement has been exceptional without the use of the spectroscope. Chemical analysis, heretofore employed, requires anywhere from 10 to 14 days, while the spectroscopic analysis is possible in a period varying from 24 to 48 hours.

Describing the detection of lead in the human brain, Prof. Cholak reports that a percentage of three-tenths per hundred grams has been found in the brain of an individual. Through the use of the spectroscope, he has been able to detect minute amounts in other parts of the body. Another advantage of this method over the chemical analysis is that very small amounts of fluid, tissue or bone are required for the test. Using known lead concentrations to add to the spinal fluid and establishing a relation between this ratio and the lead concentration, it is possible to detect one hundred millionth of a gram of lead per cubic centimetre. Dr. J. Stuart Foster, of McGill University, hopes to apply this method to the study of lead as a possible cause of multiple sclerosis.

The selenium poisoning of cattle has long annoyed ranchmen in various parts of the world. There has been no way to discover the small amounts of this poisonous element in the soil. Livestock feeding on vegetation growing on this infected soil are killed. But at last both selenium and sulphur have succumbed to the spectroscope—in this case one of special design, because of a very long wave-length in the infra-red or heat region of the spectrum. By making special adaptations, and by the use of the new infra-red sensitive photographic plates, Dr. George Harrison and Dwight Merrill have found it possible to record and measure the light emitted by the atoms of sulphur and selenium. As much as one part in a million of these substances can be detected in the presence of other materials.

Not only is the result important to cattlemen and farmers, but the method is expected to prove useful to metallurgists. Recently the presence of small amounts of sulphur and selenium in certain alloys have been recognised as an important factor in determining the characteristics of the alloy. By the use of the spectrograph the amount of these elements in the alloy can be measured accurately and kept at the right specification.

Even in the field of diamond mining the spectroscope is proving exceptionally useful to the geologist. It tells whether certain rock is the kind in which diamond is likely to be found. Although diamond-bearing rock may appear on the surface like any other rock, the spectroscope is able to tell swiftly whether diamonds may be hidden there.

What the instrument actually does is to detect the presence of so-called volcanic "pipes" formed by the explosion of volcanic lava through the earth's crust. It is this explosion with its tremendous heat and pressure that is believed to be responsible for the formation of diamonds although the exact process is not known to science. Detection of the "pipes" however does indicate the proper type of rock and thus eliminates considerable hit-or-miss prospecting. The spectroscope is also used in the study of volcanoes to identify the gases from which the molten lava is formed. Further researches in this field may assist science in forming an accurate picture of the substances which comprise the inner layers of the earth's crust.

Research Notes.

The Behaviour of the Conformal Transformation at the Boundary.

OSTROWSKI (*Acta Math.*, t. 64, 81–184) has obtained very general and precise results in this extensive and profound paper. Let G_1 be the simply connected region in the z-plane which is transformed into G by means of the Schlicht function $w = f(z)$. Let w_0 be a point on the boundary of G, corresponding to z_0 on the boundary of G_1 and let $f(z)$ be continuous at z_0. If $\Delta_z = z_0 z_1 z_2$ and $\Delta_w = w_0 w_1 w_2$ be two small triangles, then the transformation is said to be relatively conform in z_0 if Δ_z and Δ_w are similar in the limit. If $z_1 \hat{z}_0 z_2 \sim w_1 \hat{w}_0 w_2$ then the transformation is said to be "*winkel-treu*" in z_0. It is conform when $\frac{f(z) - f(z_0)}{z - z_0} \to$ to a limit other than zero or ∞. (In this case it is also called absolutely conform.) It is clear that there may be relative conformity or "*winkel-treu*" even if it is not absolutely conformal. One of the important results that Ostrowski has obtained is that if the transformation is "*winkel-treu*", then it is also relatively conformal if z_1 and z_2 are always contained in an angular neighbourhood of z_0. This follows from the result, that if $z \to z_0$ angularly in G_1, then arg $f'(z)$ also $\to$ to a limit.

As regards "*winkel-treu*" sufficient conditions were already obtained by Caratheodory; this is true whenever there is a tangent to the boundary of G at w_0 and G_1 is the unit-circle. Lindlöf proved later that if the boundary curve in the neighbourhood of w_0 possesses an "L-tangent" (*i.e.*, if all the chord-directions in a neighbourhood of w_0 approach the direction of the tangent at w_0 when the ends of the chord $\to z_0$), then arg $f'(z) \to$ to a limit when $z \to z_0$ inside the unit circle in any way. All these results are precised and generalised by Ostrowski in this work.

He has proved therefore that the necessary and sufficient condition for relative conformity is that the transformation should be "*winkel-treu*" ; for this it is sufficient that G and G_1 should have corners of equal magnitude (he has utilised a more general definition of corners than the usual) at w_0 and z_0. Now if the corners are r and r_1 ('in mag.') then Caratheodory had proved that $\frac{w_1 - w_0}{w_2 - w_0} \sim \left(\frac{z_1 - z_0}{z_2 - z_0}\right)^{r/r_1}$ when the ratio $\left|\frac{z_2 - z_0}{z_1 - z_0}\right|$ lies between two positive limits. Ostrowski has proved that in the general case arg $f'(z) - (r/r_1 - 1)$ arg $(z - z_0) \to$ to a definite limit when $z_1 \to z_0$ inside an angle in G_1. If the portions of the boundary have L-tangents at z_0 and w_0, then this is true for all approaches of $z_1 \to z_0$. This is proved by means of a "*Rand-verzerrung*" theorem, which is the following

$$\frac{\frac{f'(z)}{f(z) - w_0}}{\frac{}{z - z_0}} \to \frac{r}{r_1}$$

when $z \to z_0$ within an angle in G_1. This result is proved under a weaker assumption that the conformal representation at z_0 is angularly proportional with the proportionality factor r/r_1 instead of the supposition of the existence of corners at z_0 and w_0. This theorem has been proved by making use of a theorem of Lichtenstein which has been generalised and newly proved by Ostrowski. The theorem proved by Ostrowski is that if $P(r, \theta)$ is the value of a Poisson-integral in the inside of the unit-circle, then

$$P'_r(r,\theta) = 0\left(\frac{1}{1-r}\right) P'_\theta(r,\theta) = 0\left(\frac{1}{1-r}\right)$$

when (r, θ) approaches a point of the boundary of the unit-circle in any manner.

He has derived very many interesting results from these and has generalised his results much further. Firstly, he has considered the case when $z \to z_0$ along one side of the boundary at z_0 [Halb-seitig]. Secondly, Warschawski's results about higher derivates are precised. Thirdly, the "*Rand-verzerrung*" theorem is generalised to the case where the existence of the tangents at z_0 and w_0 are dispensed with and in their place an assumption about the relatively small oscillation of the chord directions in the neighbourhoods of z_0 and w_0 of the corresponding boundaries is introduced. Fourthly, he has examined the case when $r = 0$. In this case although all these results are not true, some of them are proved to be true.

He has also obtained an interesting set of conditions for the representation of an analytic function by means of a Poisson-integral involving the existence of certain

integrals taken over the boundary of the unit-circle.

K. V. I.

On Transcendent p-Adic Numbers.

MAHLER (*Comp. Math.*, Vol. II, Fasc. 2, pp. 258–275) has extended Gelfond's proof of the theorem, *viz.*, that for two real or complex algebraic numbers α and β [different from 0 and 1] $\frac{\text{Log } \alpha}{\text{Log } \beta}$ is either rational or transcendental to the realm of p-adic numbers also. Gelfond's proof makes use of the coefficient conditions of an integral function which are obtained by means of Jensen's theorem, *i.e.*, by means of Cauchy's residue theorem. In the realm of p-adic numbers there is no analogue of Cauchy's theorem as the Archimidean axiom is not valid. He has therefore developed a corresponding theory of analytic functions in the p-adic realm. The result he has obtained is the following.

Let p be a prime-integer and α and β be two numbers different from 0 and 1 satisfying the following condition

$$0 < |\alpha - 1|_p \leqslant \frac{1}{p} \qquad 0 < |\beta - 1|_p \leqslant \frac{1}{p}.$$

Then if $\frac{\text{Log } \alpha}{\text{Log } \beta}$ is algebraic, then it should be a rational p-adic number.

His method of proof can also be applied in the ordinary case ; so we have here another proof of this theorem. One of his lemmas furnishes an interesting theorem on the approximation of algebraic numbers. He has obtained the following :

Given a set of algebraic numbers $\alpha_1, \alpha_2, \ldots \alpha_t$ there exists a constant c depending only on them with the following property—

If $\phi(\alpha_1, \alpha_2, \cdots \alpha_t) =$

$$\sum_{h_1=0}^{N_1} \cdots \sum_{h_t=0}^{N_t} A_{h_1 \cdots h_t} \alpha_1^{h_1} \alpha_2 \cdots \alpha_t^{h_t}$$

is any polynominal, the absolute value of the maximum coefficient being A, then either $\phi = 0$, or

$$|\phi| > [e^{N_1+N_2+\cdots N_t+1} A^{n-1}]^{-1}$$

where n is the degree of the algebraic field containing the α's.

K. V. I.

The Proton-Spectra of Magnesium, Silicon and Sulphur, obtained by Bombardment with Fast α-Particles.

IN the *Physikalische Zeitschrift* (1935, **36**, p. 804), O. Haxel of Tübingen describes the results obtained by bombarding Mg, Si and S with fast α-particles from Th B + C, and comes to the important conclusion that the energy levels of the resulting nuclei, *viz.*, Al, P and Cl agree with one another within the errors of observation. This indicates that the α-particles inside nuclei have a distinct existence and that the energy levels of the remaining system of neutrons and one proton are identical. The protons dislodged from the bombarded elements were counted by means of a Geiger counter and the results obtained when the opening of the counter was screened with different absorbing foils were represented on a graph. This showed the presence of three groups of protons of range 31 cms., 40.5 cms. and 52 cms. The corresponding energies are $1 \cdot 2 \times 10^6$, $2 \cdot 0 \times 10^6$ and $2 \cdot 9 \times 10^6$ electron-volts. Since the three groups of protons obtained from each of the elements Mg, Si and S are similar, while their isotopic constitution is different, it was concluded that the proton emission was due to the most abundant isotope in each case, *viz.*, Mg_{24}, Si_{28} and S_{32}, and the difference in the energy of the proton groups was attributed to the formation of excited levels in the resulting nuclei, *viz.*, Al_{27}, P_{31} and Cl_{35} respectively. The experiments now showed that the difference between the lowest state and the first excited state and that between the first and second excited states were $1 \cdot 7 \times 10^6$ and $0 \cdot 8 \times 10^6$ *e.-v.*, $1 \cdot 6 \times 10^6$ and $0 \cdot 8 \times 10^6$ *e.-v.*, and 1.6×10^6 and 0.65×10^6 *e.-v.* respectively in the case of Mg, Si and S in this order. In other words, the differences in the energy levels are the same in the three cases within the error of observation. Thus we have here the evidence for the existence of a close relation between the nuclear spectrum and the nuclear structure.

T. S. S.

Artificial Space-Gratings for obtaining Laue-Patterns with Visible Light.

SINCE the Laue-diagrams obtained by the interference of X-rays scattered by a crystal-grating cannot be made visible on a fluorescent screen on account of too small an intensity, attempts have been made to set up space-gratings suitable for the wave-length

of visible light. So far only a very special case of a space-grating had been obtained by the reflection of a plane cross-line grating such as a uniform wire-gauze. Now W. Kramer of Stuttgart describes an interesting method of obtaining space-gratings suitable for use with visible light (*Physikal. Zeit.*, 1935, p. 841). The method depends on the formation of colloidal silver layers at distances of $\frac{\lambda}{2}$ when a photographic film, on which stationary light-waves have been formed by reflection as in Lippmann's method of colour-photography, is developed. The light forming the stationary waves is also used to project an image of a cross-grating on the photographic emulsion so that a space-grating is formed when the film is developed. As a suitable cross-grating the negative, obtained by photographing a "screen" used in making half-tone blocks, was employed. A green-ray filter was placed before a mercury arc lamp and the green light was passed through a condensing lens on to the "screen" above mentioned. An image of the screen was produced by a good photographic objective (only the Microplanar of Zeiss and the Microsummar of Leitz were found suitable) and was thrown on a photographic plate with a mercury mirror behind it for the formation of the stationary waves. In this way gratings of $9 \times 9 \times 0 \cdot 7$ mm. with grating constants equal to $8 \times 8 \times 2\mu$ were produced and showed Laue spots. These spots were however not monchromatic on account of the imperfections in the grating. Better space-gratings can be produced when better cross-gratings are employed and these space-gratings can be used to demonstrate the laws of crystal diffraction to a large audience.

T. S. S.

High Pressure Technique and its Application.

PROF. BRIDGMAN has evolved a new technique (*Phys. Rev.*, 1935, **48**, 825) of producing very high hydrostatic pressure combined with high shearing stress. Mere hydrostatic pressure has not many applications unless it be combined with high shearing stress. Many ordinary crystals which exhibit polymorphism, change their crystal structures by a shear. To effect such polymorphic transformations, shearing stress is quite necessary. Bridgman has found that ordinary paper does not change even though a pressure of 50,000 kg./cm.^{2} was applied but it changes to a translucent horn-like mass when subjected to a hydrostatic pressure with a shear. Interesting results were obtained in the case of the lead oxides. PbO_2 detonated violently leaving metallic lead while the yellow oxide, PbO, was decomposed quickly to metallic lead. The red modification of HgO and P changed to the black ones. He also found that certain substances like celluloid detonated and that certain substances combined at high pressures with detonation like Cu + S. With the intense high pressure of 50,000 kg./cm.^{2}, Bridgman has been able to effect polymorphisms in the cases of Bi, Hg, Tl, Te, Ga and I_2. Certainly these investigations of Bridgman point to a new field of research of great interest.

N. S. N.

The Two Amylases of Barley.

FROM the study of the hydrolysis of starch by amylases, two alternative hypotheses have been advanced regarding the constitution of starch: according to Kuhn, starch is a single entity consisting of α- and β-glucosidic linkages which are hydrolysed specifically by the α- and β-amylases yielding α- and β-maltose respectively; according to the other view, advanced by van Klinkenberg, starch is composite, one component designated α-starch is selectively hydrolysed by α-amylase and the other β-starch by β-amylase. The hydrolysis of starch by amylases and its bearing on the constitution of starch, has been re-investigated by Hanes (*Canadian Journal of Research*, 1935, **13, B.** 185). By employing the "Yeast removal methods" to remove quantitatively and selectively glucose, or glucose and maltose, he has shown that the products of β-amylase action on starch are exclusively maltose and erythrogranulose, the latter being an unhydrolysable residue which is precipitated by alcohol of about 50 per cent. concentration; it gives a strongly opalescent solution in boiling water and is stained blue or violet (depending on its concentration) with iodine. The action of α-amylase on both starch and erythrogranulose is characterised by (1) a partial flocculation of the substrate which occurs early in the substrate, and (2) the disappearance of the iodine colouration. Contrary to the conclusions of van Klinkenberg, α-amylase does not selectively hydrolyse the erythrogranulose fraction of starch, but produces reducing

substances both from β-starch and erythrogranulose fractions.

The hydrolysis of erythrogranulose by α-amylase yields substances capable of being hydrolysed by β-amylase, and are therefore not maltose. When a mixture of both α- and β-amylases acts on starch, the β-starch fraction would be acted upon by both α- and β-amylases, the greater part of the hydrolysis being effected by the β-amylase. The hydrolysis of the erythrogranulose fraction would be initiated by the α-amylase and the products of the primary breakdown would be further decomposed by β-amylase. There is no evidence to prove that the two fractions, β-starch and erythrogranulose, pre-exist as separate entities in starch, as the possibility of their being fragments of a single molecule must not be overlooked.

A. K.

The Determination of Mercury in Viscera.

AN improved method for the determination of mercury in viscera has been described by Clive Newcomb, S. Rajagopal Naidu and K. S. Varadachar in the *Analyst* (1935, **60**, 732). The usual method is to destroy the organic matter with potassium chlorate and hydrochloric acid under a reflux, precipitate the mercury as sulphide which is filtered off, washed with carbon disulphide and weighed. In the present method, the organic matter is destroyed with a mixture of nitric and sulphuric acids and the mercury distilled off as the chloride by drawing a current of air, saturated with HCl, through the solution containing the mercury, and subsequently the mercury is precipitated from the distillate as sulphide. The precipitate is dissolved in bromine water and filtered, to free it from sulphur, the excess of bromide boiled off, the mercury reprecipitated as sulphide which is collected on a tared gooch and weighed. A simple apparatus is described to carry out the distillation quantitatively.

The advantage of the method, besides its greater accuracy over the older one, is that it enables the separation of mercury from metals of the second group such as Copper, Bismuth, Lead and Arsenic, where they occur. Moreover, Arsenic, when it occurs together with mercury, is converted in this method to the pentavalent state and is retained in the distilling flask whence it can be recovered quantitatively.

Hairiness of Leaves in Relation to Resistance by Injury by the Potato Leaf-Hopper in Soya Beans.

THE interesting fact that pubescent types of the Soya bean are resistant to the attacks of the potato beetle leaf-hopper *Empoasca fabæ* (Harris) is brought out in a study by Johnson and Hollowell (*Jour. Agri. Research*, **51**, No. 4). Progenies of three generations of a cross between a rough hairy type and a glabrous type of soya bean were raised and tested. Glabrous individuals of both the homozygous, glabrous and the heterozygous progenies were all heavily infested with *Empoasca*, severely stunted in growth and had curled leaves with necrotic margins. The rough hairy individuals on the other hand were almost entirely free from *Empoasca* and grew vigorously and their leaves showed no symptom of leaf-hopper injury. In glabrous and appressed hairy introductions got out and grown by the side of these progenies the glabrous plants were heavily infested while the hairy ones were free. Some hairy plants contained in the glabrous introductions, probably as segregates, were also free from hoppers. Though it is probable that the resistance may be due to the hairiness or to some character the inheritance of which is controlled by the same hereditary complex as the pubescence no evidence of such a character was obtained in these experiments.

A. K. Y.

Control of the Woolly Aphid by means of Insect Parasites.

ATTENTION is drawn to the great effectiveness of the parasite *Aphelinus mali* in the control of the woolly aphid (*Eriosoma lanigerum*) in the apple orchards of New South Wales. So satisfactory has been the method that the spraying method usually adopted heretofore has become unnecessary. The effect however of the sprays which have to be used to control other insect pests and fungous diseases on apple trees, on these beneficial woolly aphid-controlling parasites has now become important to study and the same has been undertaken and the result reported by N. S. Noble (*Agri. Gaz. of New South Wales*, Vol. 46, pt. 10). The sprays studied were nicotine sulphate, various miscible oils and lime sulphur. Laboratory experiments showed that the sprays had little or no effect on the emergence of

the parasites. It is also concluded that this applies not only to the parasites which were in the pupal stage but also to those in the larval stage. Under field conditions however it is found that caution is necessary; while where the parasite is firmly established the spraying is not injurious to it, where it has been recently introduced and spraying to control other pests is also necessary then unless the parasite has had time to oviposit and its progeny are at least approaching the mature larval stage the spraying would probably result in failure to establish the parasite.

A. K. Y.

The Banded Chromosomes in the Salivary Glands of *Drosophila*.

P. C. KOLLER (*Proc. Roy. Soc. Lond.*, (B.) Oct. 1935, **810,** 371–397) regards the banded salivary-gland chromosomes of *Drosophila* to be multiple ones consisting of four-eight-sixteen chromosomes and the bands as due to the characteristic chromosomes lying side by side. The homologous multiples pair side by side and fuse into one solid cylinder, and they exhibit relic coiling before, and both relic and relational coiling after, pairing. The salivary gland nuclei are therefore in a state of perpetual prophase corresponding with a modified meiotic prophase. In the presence of intercalary inversion, relational coiling which develops, at first promotes pairing but the fixed ends of the inversion prevent normal completion of this relational coiling and hinder pairing. Where intercalary deletion occurs in one homologue reflex-relational coiling is noticed. The attraction between the attachment chromomeres is not only not specific but unlimited and thus the attachment chromomeres of all chromosomes fuse to form one body, "The Magma". These properties of coiling are analogous with those found in the prophases of mitosis and meiosis and are probably due to the analogous changes in the molecular spiral.

Chromosomes and X-Rays.

M. J. D. WHITE (*Proc. Roy. Soc. Lond.*, Ser. B., Dec. 1935, **812,** 61–84) has found that the irradiation of the spermatogonia in Locusta results in both lethal and non-lethal effects. The former lead to the pycnosis of cells while the latter lead to chromosome abnormalities, fragmentation being the commonest. The fragmentation of the X-chromosome is much rarer than that of the autosomes. Ring chromosomes and chromosomes with two spindle attachments result from fusion. Certain spermatogonial cells show a tetraploid nature as regards chromatids but exhibit only a diploid number of spindle attachments. This is regarded as a new kind of abnormality (*diplochromosomes*) and is believed to be due to inhibition of division of spindle attachments following on irradiation. The spindle attachment is independent in certain respects in its behaviour from the rest of the chromosomes. In Acridiidæ, the author regards that the spindle attachments are not terminal as is usually believed but sub-terminal. The effect of X-rays on the material at different times after irradiation have been studied and it is shown that breakage can take place in both chromatids at the same level after splitting (a possibility previously rejected by Mather and Stone) and at about the end of the resting stage there occurs a period when fragmentation and translocation occur with great facility.

Williston's Law relating to the Evolution of the Skull Bones in the Vertebrates.

PROF. S. W. WILLISTON in discussing the skull bones of Permian reptiles noted the law that evolution besides being irreversible is also a law "that the parts in an organism tend toward reduction in number, with the fewer parts greatly specialised in function, just as the most perfect human machine is that which has the fewest parts and each part mostly highly adapted to the special function it has to subserve". This law has been amply substantiated by the work of W. K. Gregory and his pupils [*Am. J. of Physical Anthrop.*, 1935, **20** (2), 123] who have closely examined the vertebrate skulls of both fossil and living forms. It has been pointed out by the authors that this law is a part of the principle called anisomerism where primitive sub-equal morphological units "become differentially enlarged, reduced, distorted or fused with the neighbouring elements". The application of this principle must have taken place during six great successive revolutionary periods. During the Silurian the agnathus forms must have been converted into jaw-bearing vertebrates. The air-breathing, lobe-finned fishes into Stegocephalian amphibians during the Devonian, and the primitive stegocephalia

into stem-reptiles during carboniferous, mark the next two stages. Permian and Trias are characterised by the appearance of mammal-like reptiles and the conversion of these into mammals. Arboreal primates are derived from primitive mammals during Jurassic to Eocene. Perhaps Upper Miocene and Lower Pliocene mark the stages of the appearance of Man. With this knowledge as a background, a count of the "number of suturally separate bones in the various sub-divisions of the skull" and also the total number of skull bones of an adult animal, has been made. It has been shown how differently the principle of anisomerism has acted in different regions of the skull.

Geologic Deductions from Earthquakes of Deep Focus.

THE prevalent view that Earthquakes generally originate at shallow depths has been challenged of late years and it has been shown by seismologists that many Earthquakes are of really deep-seated origin. From a mass of interesting geophysical data collected with regard to Earthquakes of deep focus J. S. De Lury (*Journal of Geology*, Vol. 43, No. 7) has deduced certain conclusions of fundamental importance. He has shown that since strength increases with depth, deep-seated Earthquakes require mighty stresses. Secular cooling disturbs the initial thermal gradient and the stresses caused by such differential thermal activities are responsible for Earthquakes of deep focus.

Further a doubt has been raised regarding the existence of a shell of weakness below the crust, and this has a direct bearing on the assumptions of isostasy. It is probable that records and observations of deep-seated Earthquakes will necessitate a revision of many of our conceptions of crustal mechanics.

M. R. S.

Note on the Manganese-Lime Series of Garnets.

SOME time back a bulletin (*Mysore Geological Department Bulletin*, No. 14) was published by Messrs. M. B. Ramachandra Rao and K. Sripada Rao in which it was pointed out that the analyses of the garnets contained in the Sakarasanahalli series of metamorphic rocks agreed closely with the Spessartite of the Ilmen mountains and not with the Manganese-Lime series of Indian garnets described by Dr. Fermor. On this basis it was concluded that the Sakarasanahalli series of rocks had no relationship with the Gondite and Kodurite series of Fermor, but were merely metamorphic representatives of the Hornblende Schists. Recently Dr. Fermor has shown (*Rec. G. S. I.*, Vol. 68, pt. 3) by making use of the same analyses that these Sakarasanahalli garnets must be considered as members of the Manganese-Lime series of Indian garnets. Further with the help of numerous analyses of Indian garnets, he has constructed a very instructive diagram, where it is clearly shown that the analyses of the Sakarasanahalli garnets fall well within the curve of the Indian garnets of the gondite-kodurite series. Thus he still maintains the view that the manganese-bearing garnet rocks associated with the manganiferous limestones of the Sakarasanahalli area are connected with the well-known Gondites and Kodurites.

M. R. S.

Mechanism of "Drying" of Oils.

THE mechanism of the conversion of a drying oil into a hard solid has been investigated by several workers, and the conclusions are conflicting. A new approach to the problem is made by G. Gee and E. K. Rideal (*Proc. Roy. Soc.*, 1935, Series A, **153**, 878, 116). By the study of surface pressures and phase boundary potentials, they have been able to elucidate the general mechanism. Their results show that in "drying" of a monolayer of the maleic anhydride compound of β-elæostearin a primary unstable peroxide is formed; the latter can undergo conversion into a more stable isomer or can get polymerised directly. The polymerisation reaction proceeds by the primary activation of the monomer followed by the rapid reaction of the active material with successive molecules of the inactive monomer, so that the reaction is terminated by the disappearance of the monomer. The decreasing activity of the growing polymer is shown to be completely accounted for by a mere steric factor.

K. S. G. D.

Researches on Malaria.*

"THE Transactions of the Far Eastern Association for Tropical Medicine," recently published, contains twenty papers dealing with recent researches on Malaria. The topics may be reviewed under the following heads.

The Question of Time in Control of Malaria.—It is beyond the comprehension of an average malariologist to have to look ahead fifty or a hundred years to visualise the completion of a programme. He likes to point to Panama where malaria was controlled in a matter of months, and he views with pride the recent attack on the Pontine Marshes, where a few years have seen such a splendid victory over this disease. He forgets the enormous initial costs of these two control projects, justified of course by the results, but impossible for average tropical areas.

Moreover, the malariologist tends to seek perfection in this method and is unhappy if a single larva escapes his larvicide. Yet perfection costs money and the simple truth of the matter is that the tropics cannot afford perfection in malaria control or anything else. It is time that malariologists began to rely more on Time and less on Money, insisting on continuity of effort but not on perfection, which will always be so expensive as to be either utterly impossible or fatally sporadic.

Therefore, more and more effort must be expended in searching for biological and automatic methods of control. Such methods offer little hope at present of ever being either perfect or rapid. But they do offer the possibility of continuity and of the desired results in time.

Species of Mosquitoes.—In Europe it has been shown that the puzzling fact that in some places *A. maculipennis* carries malaria and in other places not, could be explained by the existence of different races of this species.

In the Far East analogous problems exist. Why does *A. subpictus* carry malaria in the Netherlands Indies, and not in British India? Why do *A. hyrcanus* (and its varieties) and *A. aconitus*, for example, carry malaria in some parts of the Netherlands Indies and not in others? Probably in the latter cases this can partly be explained by the number of cattle present, but it seems quite possible that also racial differentiation or a differentiation into varieties might be responsible, at least partly, for this phenomenon.

Mosquito Surveys.—Since the success of local anti-malarial measures depends chiefly upon the virtual abolition of the larvæ of dangerous mosquitoes breeding within effective range of the protected villages, it is essential that a constant check be maintained over all the potential breeding places that are to be abolished within such areas. Mosquito-larvæ surveys are consequently essential, first for the discovery of all dangerous breeding places and then for keeping watch on those that need to be eradicated.

It is necessary for efficiency that the overseers in charge of oiling should have a thorough knowledge of the habits of mosquito larvæ and still more essential that constant watch should be kept over their work by other larvæ searchers whose work is independent of the oiling staff. Larvæ surveys are thus of supreme importance in the conduct of all anti-malarial works.

Permanent Control Measures.—In the Netherlands Indies the control of malaria consisted of:

(1) The installation of a drainage system.
(2) Regular cleaning of the small grassy irrigation ditches (because they also harboured larvæ of *A. aconitus*).
(3) Planting of rice only once a year in the wet season by all the people at the same time; so that during the dry season the plain was dry and anopheles breeding well nigh impossible.

The effect of this has been to transform the appearance of villages. In place of miserable and weakly children there are now sturdy youngsters. Squalor that was induced by sickness has given way to comfort and good health.

Temporary Measures.—The use of Paris green (copper acetoarsenite) to destroy anopheline larvæ was first introduced by Barber in 1921. It has been widely applied in the United States as well as in European countries. Its low cost, portability, effectiveness for killing the larvæ in thickly vegetated surface and harmlessness to other forms of aquatic life and to domestic animals are generally recognised, and its use is, therefore, universally applicable.

* *Transactions of the 9th Congress of the Far Eastern Association of Tropical Medicine*, Vol. II, 1934. Published by the National Health Administration, Nanking.

"Paris green has the advantage of not killing vegetation, as would be the case with anti-malarial oil. Its use, therefore, in the botanical gardens is of special advantage—malaria is controlled while the natural beauty of the ponds and of the river is maintained."

Anti-Malarials.—Amongst the many factors that must be considered in estimating the therapeutic value of the three best known anti-malarials—quinine, plasmoquine and atebrin—one of the most important is the toxic action of the drugs on various organs.

It is probable that these do not act directly as parasiticides, but cause recovery from malaria through indirect means. For this reason the question of the general action of these remedies on the organism is of more importance than was thought up to a short time ago.

If plasmoquine or atebrin should be administered intravenously to patients, they should always be combined with a suitable dose of adrenaline. In case of prolonged cardiac depression after the administration of plasmoquine or atebrin, besides adrenaline and its analogues, the usually employed heart stimulants must be thought of.

Taking all forms of infections together, it has been found that quino-plasmoquine is the most effective in reducing the size of enlarged spleen, the next being totaquina Type I, atebrin, quinine and totaquina Type II, in the order named.

In tertian malaria the spleen-reducing property of all the drugs is about the same with the exception of atebrin. In quartan infection they are also effective, especially totaquina Type I and quinine. In subtertian fever all the drugs are less effective, although quino-plasmoquine shows slightly better results.

Quinine and atebrin were found to be superior to the other drugs in freeing the peripheral blood from parasites both in tertian and quartan infections.

Advantages of Atebrin.—Atebrin is the best drug available for the treatment of all types of malaria, especially in the case of controlled populations.

The treatment is short, simple and effective —one 1½ grain tablet of atebrin for 5 days only; it has seldom to be repeated.

If administered as a prophylactic in the field each day's treatment may be given in one dose. Actual attacks of malaria should, if possible, be treated in hospital.

It is usually as efficacious as quinine in abating the clinical symptoms of malaria.

It is greatly superior to quinine in the prevention of relapses: judging by present experience the atebrin relapse rates do not exceed from 5 to 8 per cent. in subtertian, and from 5 to 16 per cent. in benign tertian malaria.

For this reason it is a cheaper drug to use than quinine.

Children need and tolerate relatively larger doses of atebrin than adults.

In serious cases of malaria the injection of atebrin seems as effective as the injection of quinine bihydrochloride.

The toxicity of atebrin is low.

A short course of plasmoquine not exceeding 0·03 gram daily for from 5 to 8 days should be given after atebrin treatment in subtertian malaria—to destroy the gametocytes. A similar course of plasmoquine will lower the relapse rate in benign tertian atebrin-treated cases.

The prophylactic use of atebrin is, under certain conditions, worthy of trial, because of its slow excretion from the body and its cumulative effect. A mass treatment of labour on heavily infected estates at the beginning of the malarial season should prove of value.

It is a powerful preventive of malaria in the sense that most of those treated with it, being cured, are rid of the disease and become non-infective to their fellows, except in areas where sub-tertian is predominant as atebrin seems to have no action on crescents.

To get the best results on estates all persons harbouring malaria, including infants, should be given atebrin, especially if they are newcomers. If this is done, it may be possible to decrease such anti-malarial measures as oiling on some estates during the relatively non-malarious season.

General.—The following resolution on malaria was passed by the Conference:

"The Ninth Congress of the Far Eastern Association of Tropical Medicine, recognising the pressing need for co-operative investigations in the problems of malaria control, wishes, in particular, to emphasise direct attention to the fundamental importance in malarial epidemiology of studying biochemical changes occurring in the breeding places of anopheline mosquitoes."

"This Congress considers that advances of practical utility in the control of malaria might be made if the data obtained by workers in the countries of the Far East were made comparable,"

"It is resolved, therefore, that, with the consent of the Governments concerned, such investigations, conducted in various countries, be co-ordinated through the appointment of a joint committee of chemists and malariologists resident in these countries."

B. A. RAO.

The Cape Crawfish Industry of South Africa with Some Observations on the Prawn and Crab Fisheries in India.*

By B. Chopra, D.Sc.

(Zoological Survey of India, Calcutta.)

THE recently started series of Fishery Bulletins of the Department of Commerce and Industries of the Union of South Africa, of which No. I was published in February last year, offers an excellent opportunity for taking stock of the conditions in reference to prawn and crab fisheries in India. In the present note after reviewing the report on the Cape Crawfish Industry of South Africa, a short account of somewhat similar fisheries in different parts of India is given and a few suggestions are offered for developing the fisheries along scientific and commercial lines, as is done in South Africa and several other countries.

The crawfish industry has been in existence in South Africa for a long time past, but it is only during recent years that it has been established on a firm footing. The publication by Messrs. Cecil Von Bonde and J. M. Marchand of a pamphlet entitled "The Natural History and Utilisation of the Cape Crawfish, Kreef, or Spiny Lobster, *Jasus* (*Palinurus*) *lalandii* (Milne Edwards) Ortmann" as Fishery Bulletin No. I of the Department of Commerce and Industries, Fisheries and Marine Biological Survey Division, of the Union of South Africa, shows on what sound lines the industry is being run under the helpful and vigilant guidance of the Fisheries Department.

The report is divided into two parts, the first dealing with the natural history of the crawfish and the second on its utilisation. The importance of a scientific study of the species on which the industry is based is clearly brought out in the report. Questions connected with reproduction, life-history, ecdysis, food, migration, etc., etc., have not only a purely scientific value, but the application of the knowledge acquired by their study to the various processes of the industry is of a fundamental importance.

The first chapter of the report deals with the taxonomic position of the crawfish and thirteen other allied species occurring in South Africa. It is unfortunate that the authors have called the Cape crawfish by the zoological name of *Jasus* (*Palinurus*) *lalandii*. *Jasus*, as the systematists know, is the name that Jeffrey Parker gave in 1883 to a subgenus of *Palinurus* having certain characters on which Spence Bate later (1888) founded his genus *Palinosystus*. The latter name was, therefore, so to say, still-born and *Jasus* has thus for a long time been recognised as a subgenus of *Palinurus*. Some authors, like de Man,[1] for instance, consider *Jasus* as a distinct genus, of the same rank as *Palinurus*. The correct name for the "Kreef" would, therefore, be either *Palinurus* (*Jasus*) *lalandii*, or (if the authors consider the characters on which *Jasus* is based to be of generic importance—a view that is generally held now) *Jasus lalandii*, but in no case can *Palinurus* be considered a subgenus of *Jasus*. It may also be mentioned here that Lamarck has generally been credited as the author of the specific name *lalandii*, but as this appears to have been only a manuscript name, the authors of the report are quite justified in ascribing it to Milne-Edwards[2], who was the first to publish it with a proper description. Another point of some systematic importance is that according to de Man *Panulirus fasciatus* of Fabricius 1798, should be known by Herbst's specific name of *polyphagus* 1796; the authors have used the former name in the report.

The anatomy of the crawfish is briefly described in simple language, and the distinguishing characters between the two sexes are clearly brought out. The process of reproduction is also briefly referred to, and the hatching period is stated to last from

* Published with the permission of the Director, Zoological Survey of India.

[1] de Man, *Siboga Expd. Rep.*, 1916, **39** a[2], part 3, 31-32.

[2] Milne-Edwards, *Hist. Nat. Crust.*, 1837, **2**, 293-294.

three to five months. It is of interest to note that a female crawfish may carry as many as 200,000 eggs in a single brood.

The chapter on development and metamorphosis is of special interest in spite of the fact that there are still wide gaps in our knowledge of the complete life-history of the crawfish. The importance of studying the complete cycle is strongly stressed; its practical utility is apparent in view of the fact that " the aquarium experience gained makes it possible to rear young fish with success until they have passed the 'danger zone' and can be liberated in the open sea, there to counterbalance any depletion of the sea caused by fishing". From an examination of the smallest females "in berry" it is concluded that though rarely specimens having a carapace length between one and two inches may be mature, it is oftener that examples between two and three inches are found to be carrying eggs. From evidence gained under aquarium conditions it is believed that the berried season lasts from two to three months.

Moulting being a necessary concomitant of growth, the information given under the chapter on ecdysis is both interesting and useful, but it must be stated that the published data for arriving at the rate of growth, *viz.* ·2 inch per year, are rather meagre. The smaller fish moult oftener than mature individuals, which cast off their skin at a more or less definite season each year, the season sometimes differing even in adjoining localities.

Regarding the food of the crawfish the authors are of the opinion that the "nut-cracker" jaws "have probably been provided for the breaking open of the shells of mussels and such like creatures". It will be interesting to know if this view is based on any actual observations in nature or even in aquaria. Sea weeds also form a part of the natural food of the crawfish.

The crawfish lives on the sea bottom between low-water mark and 20-25 fathoms line, and prefers a rocky bed with abundance of weeds, etc. An interesting point in this connection is that the fish is abundant on the west coast, and scarce on the east. This, as the authors point out, is no doubt due to the fact that the water along the Atlantic coast is considerably colder than that of the Indian Ocean washing the east coast.

In the absence of satisfactory results having been obtained from tagging experiments the authors have refrained from expressing any definite views on the question of migration, but it is interesting to note that one marked crawfish had travelled 13½ miles in 11 days, thus suggesting that there may be some definite migratory movements. It is hoped the new tagging methods that have been evolved after a series of experiments may prove more successful. There is no fixed proportion between the two sexes, and a dominantly male population in a particular area to-day may change into a dominantly female population to-morrow, but as such areas are generally contiguous, normal mixing of the sexes takes place without much difficulty.

The second part of the report dealing with the utilisation of the crawfish for commercial exploitation is of absorbing interest both to the scientist and to the people engaged in the industry. As is usual in such cases the history of the crawfish industry in South Africa is a tale of failures by the early pioneers paving the way to success which the present companies have achieved.

The process of canning is described in detail and the precautions taken in avoiding contamination, etc., are mentioned. That these precautions are thoroughly efficacious and that the product of the South African canned crawfish industry is entirely reliable is shown by the fact that "one large company last year paid out the sum of seven shillings and six pence in repayment of bad and damaged tins"; this sum roughly represents ·0003 per cent. of their total output. Unfortunately there have been some serious lapses also, but the whole process of canning is being thoroughly investigated with the help of an eminent chemist.

The value of the canned crawfish industry to South Africa runs into lakhs of pounds. Approximately £ 350,000 have been invested in the industry; in 1932 there were in the Union of South Africa alone 13 large factories employing 2,600 men, paying out £ 104,000 in salaries and wages, and producing canned fish of the value of approximately £ 450,000. The figures for export are equally impressive; in 1933 the Union of South Africa and South West Africa exported canned crawfish to the total value of £ 382,052. In addition to canning, an industry in the export of frozen tails of crawfish has also been established. The process involved is very simple, consisting in severing the tails from freshly caught fish, cleaning and putting them in ice and then packing and transferring them to the cold-storage chambers of steamers.

Frozen tails of the value of £ 93,840 were exported, chiefly to France, in 1933.

The types of boats used in the industry are mentioned and their evolution from the simple open dinghy equipped for sailing or rowing to the modern motor fishing boat, especially designed and built for the crawfish industry, is described. The actual fishing is, however, still done from the dinghies.

The methods of fishing have not, on the whole, developed very much since the industry began very many years ago. A simple type of hoop-net, with an iron hoop, and twine netting is used. The net is let down and hauled up by three bridles or legs, one consisting of the hauling rope itself, and the other two of thinner twine. The bait is tied at the junction of the three bridles and the nets are let down spaced at intervals, in a suitable place in about 20 fathoms of water. The fishermen working from a dinghy haul them up occasionally, take out the fish and set them again. When sufficient fish have been collected, the load is transferred to the mother boat which is anchored close by, and the dinghy resumes the fishing operations. When the fishing is over for the day, or has to be abandoned on account of threatening weather conditions—which is very often the case—the nets are hauled in, the dinghies are either stowed on deck, or secured astern by tow-ropes, and the mother boat returns home.

The various fishing grounds along the west coast are described. Their extent, nature of the bottom and the shore, their liability to winds and swells, the abundance or otherwise of the crawfish and other necessary details, like sanctuaries and the breeding seasons, are given in detail. The sketch maps showing the boundaries of the various grounds are very helpful.

The last chapter on protective legislation shows how the idea of declaring "close season" has had to be abandoned, except in a very few selected places. The present rules for the conservation of supplies seem to be based on sound scientific principles and on experience. The laying down of the size-limit, prohibition against catching fish in berry, declaring sanctuaries, prohibiting dumping of crawfish bodies and crawfish offal in the fishing grounds and such other restrictions are all eminently reasonable and in the best interests of the industry.

The bibliography given at the end, though not very exhaustive, as in a work of this kind it need not have been, is very useful. A. Gruvel's paper entitled "Contribution à l'etude générale systématique et économique des Palinuridae" published in *Annales de l'Institut Oceanographique* III, Fasc. 4 (1912) should, however, have found a place in the list of references. Besides giving a systematic account, the author deals with the commercial exploitation of the different species of the Palinuridae, and his notes on *Jasus lalandii* (pp. 12–14) are very useful.

The paper is illustrated with eight plates of the animal, its different parts, and larval stages, and nine sketch-maps of the fishing grounds. These are on the whole very clear and most useful.

Both zoologists and industrialists engaged on the crawfish and allied industries must feel thankful to Messrs. von Bonde and Marchand for the production of this most interesting and instructive treatise.

Now turning to the conditions prevailing in India, one cannot help wishing that industries like that of crawfish canning could be established in this country also. Vast quantities of prawns and crabs are sold in the markets of Calcutta, Bombay, Karachi, Madras and other important towns near the sea, and some quantities are sent considerable distances inland also. According to Moses[3] "both in quantity and value the crustaceans are of greater importance than any kind of fish in Madras. The prawns top the list, while the crabs come next." The figures that he collected for the sale of different kinds of fishes, including prawns, etc., show that prawns, crabs and shrimps to the value of Rs. 1,35,056–14–0 were sold in the markets of Madras City in one year. The figures given by Rai[4] for the Bombay coast are still more impressive. "Millions of pounds of prawns are caught annually. Apart from local consumption, large quantities are despatched inland, and also exported to foreign countries. The total consumption along the Bombay coast alone may be estimated at 12,000,000 lbs. valued roughly at Rs. 2,500,000. The prawn industry alone, along this coast gives employment to about 20,000 men, women and children." For the very rich prawn fisheries along the Sindh coast he estimates the annual yield roughly at Rs. 1,500,000. For Calcutta unfortunately no figures are available, but even a

[3] Moses, *Madras Fisheries Dept. Rep.*, 1923, No. 6, 139.

[4] Rai, *Journ. Bombay Nat. Hist. Soc.*, 1933, **36**, 887.

casual visit to any of the important markets of the town, and especially to Chingrihatta, a large flourishing market, more or less exclusively reserved for the sale of prawns and shrimps, would convince one of the large quantities of these crustaceans which are consumed at almost all times of the year.

In spite of the vast proportions of the prawn and crab fishing industry and the great possibilities of its expansion, it is regrettable to note that practically nowhere in India are these industries being run on sound scientific lines, or even on modern commercial methods. The fishermen still employ methods that their forefathers used and the advance of science or the development of modern commercial and marketing methods are altogether unknown to them. All that is done at present, as it was no doubt being done generations ago, is that fishermen in small family groups do the fishing, either for themselves, or in many cases for the middlemen to whom they are heavily in debt, with small country boats and antiquated appliances. The catch is sold fresh, mostly through rings of middlemen, in the markets of neighbouring towns, or where facilities are available, is sent some distance inland. It must, however, be admitted that some of the simple and primitive methods and appliances used by our fishermen are at least as efficient as those employed in countries where fisheries are being more scientifically handled. In some cases where the yield is more than the requirements of the neighbouring markets, prawns are dried, or even boiled and dried, and are exported in fairly large quantities. The methods employed are of the very simplest kind, drying being done mostly in the sun, separating of the shells by trampling or by thrashing with sticks and packing for export purposes in gunny bags. In a few places in the Madras Presidency, however, through the efforts of the Fisheries Department, improved methods are being tried and gradually adopted. It is remarkable that even in spite of these, for the most part, primitive methods a large export trade in dried prawns and of their shells—the latter are used for manure—exists in a number of centres, Karachi alone having exported these commodities to the value of Rs. 11,59,797 in the year 1929–30. Similar flourishing trade exists near Calcutta, in some places in the Madras Presidency, notably on the Malabar Coast, and also on the Chilka Lake on the Orissa Coast. Very little canning is being done anywhere at present; it was tried in Madras for a number of years, and the success, perhaps only partial, that was achieved by the Madras Government Cannery indicates that, if properly handled, a flourishing trade in the export of canned prawns could probably be set up in a number of centres along the coast.

Species like *Penaeus semisulcatus* de Haan and *Peneopsis monoceros* (Fab.) are found in abundance in suitable places all along the Indian coast and are fished in quantities to supply mostly the requirements of the local markets. These and some others are large-sized species and if organised attempts were made to do the fishing and canning, etc., on modern lines, a flourishing industry could no doubt be set up in a comparatively short time, both for supplying the local markets and also for export purposes. *Palaemon carcinus* (Fab.) also attains to a very large size and is plentiful in freshwaters and estuaries in a number of localities and could perhaps be commercially exploited on a larger scale than is being done at present. There are also several smaller species of *Palaemon*, *Leander*, *Caridina* and *Acetes* that are fished in enormous quantities all along the coast.

The crab fishing industry of India is not so extensive or important from the point of yield as that of prawns. The commonest edible Indian crab, *Scylla serrata* (Forskall), forms the basis of very extensive fishing all along the coast. In some creaks of the Gangetic Delta it is so plentiful at certain times of the year that boat-loads of it are collected by some very simple, but rather ingenious, devices.[5] *Varuna litterata* (Fab.) is another species that occurs all over the Delta in countless millions, but on account of its small size does not fetch much price. The Portunids *Neptunus sanguinolentus* (Herbst) and *N. pelagicus* (Linn.) are, however, large-sized species and are fished in fairly large quantities in many centres. Added to these there are some Potamonids—*Partelphusa* (*Paratelphusa*) *spinigera* (Wood-Mason) in Bengal, *Paratelphusa* (*Oziotelphusa*) *hydrodromus* (Herbst) in Madras and *Paratelphusa* (*Barytelphusa*) *jacquemontii* (Rathbun) on the Bombay side—that fulfil the needs of the local markets.

The lobster fishing industry could also

[5] Hora, *Curr. Sci.*, 1935, **3**, 543-546.

probably be established on a more paying basis than is at present the case, on the Bombay coast and perhaps in some other places also. *Panulirus ornatus* (Fab.) attains to a size of about 12 inches or more and is found in large numbers on rocky beds below the low tide marks in several places along the Indian Coast. Another species *Panulirus polyphagus* (Herbst) [=*P. fasciatus* (Fab.)] also grows to a large size, but is perhaps not quite as abundant as *P. ornatus*. Lobsters fetch a high price in the market and could probably be used for a flourishing canning industry. On account of their spiny shell they do not find a ready sale in some markets.

The first requirement for putting the prawn and crab fishing industry on a sound footing is to study scientifically the species concerned. Efforts should be made to thoroughly investigate their bionomics, charter the grounds on which they flourish, study their breeding seasons, life-histories, migration and several allied problems. That even elementary principles for safeguarding the industry are ignored at present can be judged from the fact that intensive fishing is sometimes carried on even during the season when the females are breeding and it is by no means uncommon to see females in berry being openly sold in the markets. In countries where these fisheries are run on scientific lines this state of affairs could not be tolerated. In the Union of South Africa, for instance, not only is the capture and sale of any female crawfish in berry prohibited by a proclamation, but even the purchase and possession of such animals is illegal. Protective measures will have to be strictly enforced in India also, but to be useful and effective they must be based on a scientific study of the species concerned.

Spasmodic efforts have been made in the past by some Local Governments to study some of the problems connected with fisheries, but they have had very limited benefit towards the permanent improvement of the industry. Unfortunately all these efforts have not always been in the right direction; for instance, in the words of Annandale,[6] several years ago "when the Government of Bengal wished to prospect the marine fishery of the Bay, they got out a steam-trawler fitted for work in the North Sea and the Arctic Ocean." Ventures like this are seldom successful, and any little progress that has been made is chiefly due to the unceasing efforts of some of the Fisheries Departments. Probably the best organised Fisheries Department in India at present is that of the Madras Government and the successive Directors of this Department have done very valuable work for the improvement of the fishing industry in general: that connected with crabs and prawns also has been receiving a certain amount of attention. In a country like India, however, with vast coastal and inland fisheries several departments like that at Madras are needed. But as the fundamental problems of fisheries are everywhere more or less similar, some central co-ordinating organisation could make the work of these departments considerably easier and lighter by taking up some of the important scientific problems connected with their work. If a body like the Imperial Council of Agricultural Research could be induced to extend its activities to the investigation of some of these problems, a great deal of good would be done to this struggling, but potentially very valuable, industry.

[6] Annandale, "A Naturalist's view of the Chilka Lake", *Calcutta Review*, 1915, p. 14.

Lithium Fluoride as Lens Material.

PROF. Donald C. Stockbarger of the Massachusetts Institute of Technology announced before the recent meeting of the American Physical Society in Baltimore the preparation of optically perfect lithium fluoride crystals, over 3 inches in diameter. This discovery is considered to constitute a very important development in the field of optics.

Lithium fluoride crystals possess the ability to transmit light waves from high in the infra-red region, through the visible band and extending into the invisible ultra-violet region. This range of transmissibility is not possessed by any other known substance. According to a staff correspondent of the *Christian Science Monitor* (November 30, 1935), Prof. Stockbarger, at the meeting of the American Physical Society, produced motion picture reels showing his laboratory work.

The lithium fluoride is first powdered, then melted in a platinum crucible in a specially designed electric furnace provided with a device for temperature control. After the fluoride has melted, the melt is seeded with a tiny crystal of lithium fluoride and the cooling is allowed to take place slowly. Lithium fluoride crystallises in cubic formation and can be cut and polished easily.

Fruit Growing in the Plains.

By K. C. Naik, B.Ag. (Bom.), M.Sc. (Bristol).
(*Superintendent, Fruit Research Station, Kodur.*)

ALTHOUGH fruit growing in the plains has been practised from time immemorial, it is only very recently that, as a commercial industry, it has begun to make an appeal to the rural classes in this Presidency. The phenomenal success achieved in the development of fruit industry in other parts of the world, the recently accumulated scientific evidence on the valuable dietetic qualities of fruits combined with the general post-War depression in the price of the agricultural produce, have been to a large extent responsible for inducing the agricultural classes to take up commercial fruit growing in right earnest. The few pioneer attempts that have been made here and there in the Presidency have stimulated this desire by demonstrating the fact that fruit growing, if carried on properly, is one of the most paying agricultural professions.

In recent years, it has been the good fortune of some of the fruit growers of the Kodur Firka to get an annual income of over a thousand rupees per acre from citrus growing. Such huge profits have, no doubt, served as an incentive for the rapid extension of acreage under this fruit in several parts of this Presidency.

The Government of Madras have fully realised the importance of giving an impetus to this industry for a long time past. Thanks to the Imperial Council of Agricultural Research, who generously made a grant of about Rs. 66,000 spread over a period of five years, the Government of Madras have now been able to give a practical shape to its desire of furthering the industry by the starting of this Research Station in the centre of an important Citrus and Mango Belt of this Presidency. The above grant was supplemented by the Madras Government to the tune of Rs. 12,000 towards the cost of land. The sanctioned scheme includes a recurring annual grant of Rs. 3,500 towards working expenses besides, pay and allowances of staff and a non-recurring grant of Rs. 8,656 towards buildings, Rs. 3,000 for fencing, Rs. 600 for livestock and Rs. 1,000 towards other miscellaneous requirements.

The Fruit Research Station at present comprises an area of about 50 acres, and in addition to the Superintendent, it has a staff consisting of a Farm Manager and a fieldman. Although the land was taken possession of on 1st March 1935 the actual research work can be said to have commenced in the beginning of August 1935 when the Superintendent took over charge of the Station. Though the aim of the Station is to tackle problems involving all aspects of fruit growing, it is manifestly impossible to do all this simultaneously for various obvious reasons. Among the major problems to be dealt with, are the introduction and trial of almost all the varieties of citrus, mangoes and other fruits of proved merit and of acknowledged importance in the fruit trade, with a view to find out the most suitable and commercially profitable ones to the region. Side by side, a comprehensive scheme of experiments on the cheapest and most convenient methods of raising trees with the ultimate object of stocking our gardens with healthy, vigorous, precocious and most productive trees, budded or grafted as the case may be on most desirable stocks, are proposed to be taken up. Every fruit grower realises the very great importance of this work, for, the selection of stocks and method of propagation makes all the difference between failure and success in the case of permanent crops like fruits, particularly because of the fact that the result of the defective nursery practices would become evident only six to eight years after planting.

Besides these, it is well known that there are other problems like cultivation, manuring, irrigation and disease and pest control of fruit trees with which the fruit growers are at present almost entirely in the dark, as is evidenced by the marked variation in the orchard practices from place to place. The research station aims at standardisation of such practices and impart knowledge of practical value in all these various aspects of fruit culture.

There is another aspect in which the fruit growers are at present greatly handicapped and that is the purchase of reliable nursery plants. Without dilating much upon this important phase it may however be stated that the failure of many gardens all over the Presidency is in a large measure due to planting of useless trees of unknown parentage, sometimes supplied even under wrong names. The Research Station wishes to solve this difficulty by arranging to supply, if possible, reliable plants of known parentage propagated from trees of proved merit.

These problems are also intimately connected with the proper nomenclature and classification of fruits—a subject on which there exists at present very great confusion and therefore needs to be dealt with exhaustively.

Food Investigation.

THE report of the Food Investigation Board for 1935 (His Majesty's Stationery Office, 4 *sh.* net.) contains a number of items of general and scientific interest. Amongst them may be mentioned the successful experimental shipments of chilled beef from New Zealand, stored in air enriched with carbon dioxide. This method enables the chilled beef to be stored from 60 to 70 days. With regard to fruit storage, the value of iodised paper as a wrapping material has been demonstrated. The method delays the development of fungi which cause rotting by considerably retarding the growth of the germ tubes. It can be employed without impairing the flavour, for grapes and other fruits, but as yet the method is unsatisfactory with peaches and some varieties of plum.

It has been found that the concentration of Vitamin C in an apple increases as the skin is approached and is six times as great in the peel as in the region of the core. In the variety "Bramley's seedling", it was found that the rosy apples had more than twice the vitamin potency of those with green skins. Canning appears not to impair the vitamin activity to any great extent and successful results have been obtained in the addition of synthetic Vitamin C to tinned products such as spinach and runner beans which do not naturally contain it.

—*Science Progress*, 1936, **30**, 521-22.

Relativity and the Expanding Universe.*

By Prof. A. C. Banerji, I.E.S., *Allahabad*.

APPEARANCES are deceptive. Stars appear as mere points of light but we know that they are great radiant orbs much bigger than our earth. A piece of copper appears to be a perfectly continuous body, but we know now that it consists of millions of molecules none of which is in contact with others. The whole progress of Science is a continual discovery that things are not what they seem. A penny may appear to be a circular disc to an observer when seen from one point of view, whereas it may look like a very narrow rectangle when seen from a different point of view. But both these observations are consistent with the conception of a penny as a three dimensional object, *i.e.*, a very short cylinder. Science really tries to reconcile different observations of every normal person.

Time, we say, goes on quickly when we are pleased or excited, and slowly when we are bored. Then we are able to draw a distinction between psychological time which is qualitative and is measured by our sensations and the clock-time which is quantitative and is used in physical science. In actual life time is filled with qualitative values. Lines of Scott express this fact very well :—

"One crowded hour of glorious life
Is worth an age without a name."

Time and space are inter-connected. We do not perceive points of space or instants of time—we perceive point-instants or events. One may say that the top of the Muir College Tower, (Allahabad), which we perceive is a definite point of space. It may be definite with respect to a set of axes, say, in Allahabad Station, but these axes are moving with the earth which is moving round the Sun which is itself in motion with respect to the so-called fixed stars and so on. So we cannot determine the height of the top of the tower without bringing in time. An event has both a place and a time and is not completely specified unless its place and its time are stated. A historian has, perhaps unconsciously, got this notion when he says "Battle of Plassey, 1757". Here he is specifying an event completely for he indicates the place (Plassey) and the time (1757). Similarly, he says "Battle of Waterloo, 1815".

We have no knowledge what is the same place at two different times nor can we find out what is the same time at two different places. There cannot be any absolute simultaneity of time or space. We can imagine that on a still day we have two soundless motor boats, side by side just in the middle of a straight canal. Although the two boats happen to be side by side at a given moment, one is supposed to be at rest and the other is moving rapidly. Now at the same instant shrill whistles are blown at each end of the canal. The observer on the stationary boat hears the whistles simultaneously whereas the observer on the other boat hears that whistle first towards which he is moving. So we conclude simultaneity of sounds depends on the velocity of the observer.

From the Michelson-Morley Experiment, two conclusions are possible, either the earth is at rest or the measure velocity of light is independent of the velocity of the man who measures it. The second possibility is a novel one and is contrary to old Newtonian conceptions of absolute rest and absolute measurement of length. Astronomers show by very powerful evidence that the earth is not at rest, so we are left with the second alternative, however strange it may appear. In *Adventures of Sherlock Holmes*, Holmes in explaining his method of getting at the truth to his friend Watson says. "It is an old maxim of mine that when you have excluded the impossible, whatever remains, however improbable, must be the truth."

We are then compelled to discard our notions of absolute rest and motion. Objects which appeared independent of the observer are now seen to be subjective taking a form and content determined by their relation to him. They cannot have the independent and separate property of being large or small, quick or slow, heavy or light. If time and space of an event are measured separately these separate measurements will differ with different observers. But the simple combination of them in the form (square of space measurement)—(square of time measurement) both being expressed in certain defined units, is found to be the same for all observers. Suppose an aviator travels with uniform speed in an aeroplane from Allahabad to Calcutta, and measures the distance between the two places and times the journey by his watch. Suppose also that an observer gets on the top of a very high tower from which he is able to see both Allahabad and Calcutta, and he measures the distance between these places and the time occupied by the journey. We shall find that separate measurements of both time and space will differ—although imperceptibly—and we suppose also that instruments are so delicate that these differences can be observed. But if each of the observers subtracts the square of the time measurement from the square of space measurement the results would be identical. So if we square the distance from Plassey to Waterloo and subtract this quantity from the square of the time interval between the years 1757 and 1815, the result will be the same whether the observer is on the Moon or Jupiter or on a possible planet of Star Antares.

Nature is a continually renewed body of events in a four dimensional continuum in which both space and time are inter-connected. The name Relativity given to the new theory embodying the above notion is rather a misnomer. It is true that space and time are relative, but there is also an absolute quantity—the event. This is the principle of "Unique Absolutism". It rather exalts the "Absolute" and dethrones "Relative". Event was so long relative as it depended separately on space and time. It is now *absolute*.

* Summary of Extra-mural lecture, *Allahabad University*. By Prof. A. C. Banerji, I.E.S., M.A. (Cantab.), M.Sc. (Cal.), F.R.A.S. (Lond.), F.N.I., Allahabad, Dec. 1935.

Mathematicians have postulated that three kinds of space may be possible—*viz.*, Euclidean, hyperbolic and spherical (Riemann). Propositions in hyperbolic geometry or Riemannian geometry can be translated into analogous propositions in Euclidean space. So if there be no inconsistency in Euclidean geometry, there will not be any inconsistency in the other geometries. This is what is called by Poincaré as "the dictionary method of proof". A simple analogy between French and English may make the point clear. Any idea capable of being expressed in English can equally be well expressed in French—we cannot say one language is more perfect than the other. Similarly, we cannot say that Euclidean geometry is more perfect than the Riemannian geometry. Each is self-consistent and is found to be within limits of our empirical observations, but when we have to explain astronomical phenomena we find that Riemannian geometry suits us better. In accordance with Einstein's theory of Relativity, matter is responsible for curvature of space dimensions. Space if there be matter inside it bends round until it closes up.

Initially gravitation balanced repulsion, but it was an unstable condition. A slight disturbance must have caused the original space (containing matter) or the universe to contract or expand. Eddington and Lemaitre maintain that the universe is expanding. The spectrum of a star or a nebula has got a number of dark lines which are found to be shifted from their proper positions when compared with light from terrestrial sources. In most of the nebulæ the shift is towards the red end of the spectrum and the light emitted by a nebula when it reaches the earth has larger wavelength and smaller pitch than the normal. It is a matter of common observation that the sound emitted by a motor car horn becomes lower in pitch when it is receding from us than when it is coming towards us. So it is a possible explanation that the nebulæ are receding from us. It is also found that the velocity of recession of a nebula is proportional to its distance from us. So we may have been originally bounded in a nutshell, but as the universe is steadily increasing we may rightly think that we are gradually conquering infinite space.

Other explanations may be possible for the shift of spectral lines, some of these theories are more novel and more grotesque than the theory of expanding universe. We are not really in a position as yet to know the exact truth.

An astrophysicist can verily be compared to a blind man seeking for a black cat in a dark room that is not there. The present position of a scientist may be summed up as follows :—

"Nature and Nature's laws lay hid in night
God said, 'Let Newton be' and all was light
But not for long. The devil howling 'Ho'!
Let Einstein be, restored the *status quo*,
For how long? the sceptic smiling ask
No answer comes, Nature puts on her mask."

Chemistry in Modern Warfare.*

By Sir Martin Forster, F.R.S.

THERE are so few fundamental phases of twentieth century war into which chemistry does not enter, that it is unhappily permissible to define modern warfare as chemistry applied to the destruction of life and property. The principal factors in such warfare, other than the human beings who use them and are destroyed by them, are propellents, high explosives, detonators, poison gases, screening smokes, toxic smokes, incendiaries and gas masks.

A successful propellent must produce a relatively large volume of gas in an orderly and progressive manner, this purpose being best fulfilled by cordite which began to supersede gun-powder nearly fifty years ago. Cordite is a tough, amorphous, waxy solid produced by compounding the trinitrates of cellulose and glycerol (better known as gun-cotton and nitro-glycerine respectively) with vaseline, acetone also being used to facilitate incorporation. Gun-cotton being a trinitric ester of cellulose is a chemical step-sister of artificial silk in one of its forms, namely, acetylcellulose.

The most commonly used high explosives are picric acid (formerly called lyddite) and trinitrotoluene, familiarly known as T.N.T., the former is obtained from phenol (carbolic acid) by nitration, and as the quantity of carbolic acid obtainable from the purification of illuminating gas was inadequate when the Great War began, phenol came to be manufactured in large amounts from benzene. T.N.T. is obtained by the same process (nitration) applied to toluene, a new source of which was found in Borneo petroleum. Both picric acid and T.N.T. are yellow solids; they are melted and poured into the shells where they are detonated by mercury fulminate.

The sudden demand for cordite, picric acid and T.N.T. caused by the outbreak of the Great War led to a corresponding demand for nitric acid, and a far-reaching consequence, immeasurably important because it unhappily lengthened hostilities by two or three years, was the manufacture of nitric acid from air nitrogen by the German chemists. Before the War, the principal source of nitric acid was Chile saltpetre, and when the naval blockade deprived Germany of this material it was found that the accumulated stock in that country would be consumed before the close of 1915. Further attack on the allies must then have ceased. Confronted by this quandary, German chemical resource displayed itself in dauntless measure. Already there were known several ways by which inert atmospheric nitrogen could be fixed, the principal ones being the arc process of Birkeland and Eyde, and the catalytic process of Haber. The former required unlimited electric power in which Germany was deficient, so the Haber process by which nitrogen is combined with hydrogen to

* Summary of a lecture delivered on 10th January 1936 in Bangalore (University Extension Lecture, University of Mysore).

form ammonia, came to be adopted. Ostwald had shown how ammonia may be catalytically oxidised to nitric acid, so by linking the Haber and Ostwald processes Germany provided herself with the vast quantities of nitric acid required for continuing the war.

Coming now to the so-called poison gases, it will be appropriate briefly to comment on the history and ethics of gas-warfare. In the first place it will have been observed that it is erroneous to imagine that the term chemical warfare applies only to gas-warfare. All modern warfare is chemical warfare and gas-warfare is only one aspect of it. Moreover, the idea at least and to some extent the practice of gas-warfare is by no means new. The Spartans, earlier than 400 B.C., used sulphur dioxide, and similar use of poisonous gases was made in the Middle Ages. During the Crimean War (1853-56) it was proposed to use sulphur dioxide against the Russians, but the British Government of the period rejected that plan on the ground of humanity. At the Hague Congress of 1907 it was expressly forbidden to use poisons or poisonous weapons in war.

It was therefore a complete and overwhelming surprise when, on April 22nd, 1915, the Germans launched their first gas attacks using chlorine projected from pressure-cylinders containing the liquefied gas. It occurred on the north-west part of the Ypres salient, and the effect was disastrous. A breach, both deep and wide, was made in the Allied line, and had the Germans been ready to follow up their advantage the result might have had a rapid and permanent effect on the course of the War: but happily they surprised themselves as well as the Allies, and the only permanent effect was adoption of reprisals. In May 1915, it was decided to organise a gas service which became effective in September and until the Armistice in November 1918 gas-warfare became an increasingly important branch of the conflict.

Chlorine was the most readily available of the poison gases, the pre-War manufacture being enormous owing to its use in the manufacture of bleaching powder. Moreover, it is the foundation material of other poison gases, of lachrymators and sternutators, while conversely it was used for sterilising the drinking-water required by the armies. Following chlorine there came in December 1915, phosgene, a compound of chlorine with carbon monoxide. Phosgene is much more toxic than chlorine, and being chemically less reactive, protection from it is more difficult. Fortunately the British were informed beforehand of its intended use, and were therefore ready with hexamethylenetetramine in the masks.

Mustard gas (dichloroethyl sulphide) was first used in the War by the Germans at Ypres in July 1917. By this time wave-attacks had been largely superseded by shells containing the noxious materials, this being widely distributed when the shells burst. Consequently and in view of its low vapour pressure mustard gas-attacks were always made by shell. The first was another surprise, causing twenty thousand casualties in six weeks, the physiological action being disastrous and peculiar. As in the case of poisoning by phosgene, there is a latent period before any effects are noticed, the most characteristic of these being the vesicant, or skin-blistering action, which occurs from four to twelve hours after exposure to the vapour or splashes. This action is much more intense when the skin is wet than on dry skin; consequently the effects on the eyes and lungs are frightful, besides being toxic. It lingers for two or three days in the warmest weather; while in cold, damp weather it is dangerous for a week or ten days. It is only slowly destroyed in the earth, so that digging round shell-holes remains dangerous for months.

Besides the foregoing, there were used as poison-gases chloropicrin and diphenylchloroarsine (sneezing-gas), but the deadly Lewisite was elaborated only as the War closed, and was never used on the battle-front. Lachrymators, that cause involuntary weeping which leads to temporary disablement, were usually bromine compounds, *e.g.*, bromoacetone, benzyl bromide and bromobenzyl cyanide. With improved efficiency of gas-masks these diminished in importance being useful chiefly against unprotected troops.

Screening-smokes have great practical value and are produced by burning phosphorus or by launching into moist air the vapours of tetrachlorides of tin, silicon, or titanium, all of which are thus converted into the hydrated metallic oxides. Latterly came Berger Mixture (containing zinc, carbon tetrachloride, sodium chlorate, ammonium chloride and magnesium carbonate), used in the smoke box and smoke candles. Toxic smokes are screening-smokes which carry a poison-gas, diphenylchloroarsine for instance. Another type of smoke is used for signalling, and depends on volatilisation of organic dyestuffs, *e.g.*, chrysoidine, auramine and indigo. Incendiary bombs depend principally on thermite (aluminium and oxide of iron), but as its action is confined to a small area and being rapid, quickly disperses the heat-energy, thermite is used in conjunction with so-called solidified oil, *i.e.*, petroleum absorbed by soap.

Measures taken for defence against gas revealed ingenuity and resource corresponding to the demands made by complications in gas-warfare, and led finally to the box-respirator, whose essential mechanical features are: (1) an enclosed face-piece protecting the eyes and skin, (2) a flexible hose connecting this with a canister of absorbents, (3) an exhalation valve, and (4) an efficient packing of chemical absorbents in the canister. The requirements of an efficient absorbent are: (1) Absorptive activity, *i.e.*, a very high rate of absorption, (2) Absorptive capacity, *i.e.*, the material must hold large gas-volumes per unit weight, (3) Versatility, *i.e.*, protection against any kind of toxic gas, (4) Mechanical strength to resist conditions of transport and field-use, (5) Chemical stability, *i.e.*, escape from deterioration with time, and (6) Low breathing-resistance, importance of which may be realised from the fact that a normal man when exercising violently, inhales about 60 litres of air per minute. The absorbents best qualified to meet these requirements are activated charcoal made from cocoanut-shells, and soda-lime with a small proportion of sodium permanganate.

Having now surveyed some applications of chemistry to modern warfare, some remarks

may be offered on the non-technical aspect of these applications. In the first place, you will have seen that the popular use of the term "chemical-warfare" in connection only with poison-gas is erroneous: all modern warfare is chemical warfare and superiority is determined by capacity to manufacture and skilfully to apply chemical materials. In the second place, it is erroneous to regard gas-attacks as more inhumane than destruction with explosives or bayonets; probably this misconception is owing to the frightful results of such attacks on unprepared troops. After the first surprise and consequent elaboration of protective measures gas-attacks were far less destructive than bullets and explosives. This appears very clearly from the official casualty-lists of the American troops, who, coming late into the War, were fully prepared against gas. In round figures, 25 per cent. of all casualties from bullets and explosives resulted in death, while of those wounded by gas only 2 per cent. died. It is thus fallacious to blame Science for having made War, more inhumane. War is the most brutally inhumane agency imaginable and introduction of scientific methods only implies that the power commanding superior inventiveness must ultimately prevail. The famous American naval expert, Admiral Mahan, who wrote a masterly and arresting book entitled "The Influence of Sea-Power upon History" was an American delegate at the Hague Conference of 1899, when several of the more prominent nations of Europe and Asia, including Germany, pledged themselves not to use projectile whose only object is to liberate suffocating or poisonous gases. The United States never signed the declaration, and Admiral Mahan stated his position in these words:

"The reproach of cruelty and perfidy addressed against these supposed shells was equally uttered previously against fire-arms and torpedoes, although both are now employed without scruple. It is illogical and not demonstrably humane to be tender about asphyxiating men with gas, when all are prepared to admit that it is allowable to blow the bottom out of an ironclad at midnight, throwing four or five hundred men into the sea to be choked by water, with scarcely the remotest chance to escape."

The subject needs clear thinking. To me, the criminal aspect of poison-gas lies in breaking the agreement not to use it.

The Place of India in Pre-History.*

THOUGH absolute dating in time is impossible in pre-history a geological chronology can be constructed, and at the time when man appeared glacial deposits were being formed in the north, while in the tropics corresponding climatological changes have resulted in deposits the relation of which to those further north is now being investigated.

The evolution of man's brain from lower to higher levels is reflected in the degree of perfection achieved in the tools he used and, as different types of tools form a sequence agreeing with the sequence of geological strata, they afford the best available evidence of the course of human evolution during the early Ice Age, human fossils being fragmentary and very rare.

In Europe the most primitive tools are called Eoliths or "dawn stones". From these tools, which are so crude as to be scarcely recognisable as such except to a trained eye, the sequence passes through successive stages of finer and finer workmanship in the process of flaking by which they were made, to more useful artifacts upto those of the Neolithic Age of polished stone which in its turn passed into the metal era. Each stage —Chellean, Acheulean, Mousterian, etc.—is named after a type station in Europe, and such cultural stages are well defined and easily recognisable. But the evolution was not smooth, for in Europe two civilisations are found to have alternated, fluctuated and finally merged as the peoples respectively advanced and dominated or fell behind, till at last they were assimilated the one into the other. The first of these groups is called the Core Tool People since they generally used as implements stone cores shaped by the striking off flakes. The second is called the Flake Tool People, since they used as implements flakes struck off from a core — a difference in method of manufacture involving a fundamental difference in psychology. It seems likely that the Flake peoples of Europe were invaders from Asia and the Core peoples from Africa. The Mousterians were probably a mixture of the two, though there were later invasions from Asia during Upper Palæolithic and Neolithic times.

A somewhat similar history can be traced in Africa. But there the core technique was definitely dominant while the flake technique did not gain much hold except in the north, where Asiatic influence would be more readily felt. In China, on the other hand, all cultures so far studied are flake cultures, the earliest being rather Mousteroid in form but of a coarser type, though lately a core-pebble culture similar to that found in North India has been reported.

The special importance of India for the proper interpretation of the facts of pre-history lies in her position in the geographical centre for Europe, Africa, China and Java, as well as in the many artifacts known to occur there and in the Primate remains of the Siwalik deposits which give grounds for hope that humanid remains may eventually be found there also, especially in view of the hypothesis put forward by physical anthropologists that the strenuous climatic conditions resulting from the uplift of the Himalayas were deciding factors in human evolution.

Research in India is also needed to throw light upon the origin of the Asiatic invasions of Europe in Aurignacian and Neolithic times, for it is in India that the earliest proto-Neolithic tools of Asia seem to occur; while the apparent absence of true Asiatic flake cultures from India also calls for further investigation. Though Asia may open the door to a true concept of the pre-history of man, India holds its key.

* A brief summary of the lecture delivered by Mr. T. T. Paterson of the Vale-Cambridge India Expedition, on Thursday, November 28, under the auspices of the Archæological Society of South India, Madras.

Science Notes.

New Year Honours.—The names of the following men of science are included in the list of the recipients of the New Year Honours :—

KNIGHT BACHELOR : Mr. B. C. Burt, Officiating Chairman of the Imperial Council of Agricultural Research.

O. B. E. : Dr. S. S. Bhatnagar, Director of the University Chemical Laboratories, Punjab University.

C. I. E. : Dr. C. C. Inglis, Superintending Engineer, Deccan, Bombay ; Mr. R. S. Allan, Director of Agriculture, U. P.

SARDAR BAHADUR : Rai Saheb Subedar Mula Singh, I.O.D., I.M.D., First Asst. to the Director of Nutritional Research, I.R.F.A., Coonoor.

KHAN BAHADUR : Mian Muhammad Afzal Husain, Principal, Punjab Agricultural College, Lyallpur.

RAI BAHADUR : Babu Saharda Kanta Ganguli, Professor of Mathematics, Ravenshaw College, Cuttack ; Rai Sahib Kumarnath Bagchi, Chemical Analyst to the Government of Bihar and Orissa, Public Health Department, Patna.

RAO BAHADUR : Mr. S. Sundara Raman, Government Mycologist, Coimbatore ; Mr. Vinayak Atmaram Tamhane, Officiating Chief Agricultural Officer in Sind ; Rao Sahib Y. Ramachandra Rao, Locust Research Entomologist, Imperial Council of Agricultural Research.

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Assamese Coins.—At the ordinary meeting of the Asiatic Society of Bengal, held on Monday, 6th January, Mr. H. E. Stapleton presented a paper entitled "*The Countess Amherst Collection of Assamese Coins*".—"In July 1934, Sotheby and Co., London, advertised for sale, among other lots, a collection of 12 Gold and 72 Silver coins which were listed as 'the Countess Amherst Collection of Assamese Coins'. A Ms. description of these coins by Dr. Horace Hayman Wilson, Secretary of the Asiatic Society of Bengal from 1811-1833, was included in the lot, from which it appeared that this collection was probably made shortly after the first Burmese War of 1824-6 at the instance of the then Governor-General, Lord Amherst, who was created Earl Amherst of Arakan after the conclusion of the War. It seems likely, from Dr. Wilson's note of 1828, that the agent employed by Lord Amherst was Capt. Neufville, Intelligence Officer during the War, and, later, Commandant of the Assam Light Infantry."

Mr. Stapleton was able to purchase the collection on behalf of the Government of Assam. Examination showed that it included at least 10 gold and 38 silver Assamese coins that were new to the Provincial Cabinet at Shillong. The coins which have been figured in the plates accompanying the paper are : Half and Quarter rupees of Siva Simha and Queen Ambika; ½-rupee of Rajeshvara in Nagri script; two rupees of Gaurinātha with curious dates; ¼-rupee of Bharatha; Mohur of Brajanātha of 1740 *Sakā*; and finally, a ½-rupee of Jogeshvara of 1740 *Sakā*. These coins have not been previously described.

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Discovery of the complete skull of a primitive carnivore, a flesh-eating mammal about the size of a cat, which lived in the lower Paleocene Epoch about ninety million years ago, has been announced by Dr. Glenn L. Jepsen of Princeton University. The skull was found by the 1934 Scott Fund Expedition, of which Dr. Jepsen was the Chief Director, in the Big Horn Basin of Wyoming about 25 miles north-west of Cody. With the exception of specimens uncovered by the 1935 expedition, which have not as yet been studied, it is believed that this is the only complete skull of the earliest known primate, the order to which monkeys, apes and man belong.—(*Science*, Nov. 22, 1935, *Supp.* 8.)

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South Indian Bronzes at South Kensington.—It is announced that, by a bequest of the late Lord Ampthill, former Governor of Madras, the Victoria and Albert Museum, South Kensington, has recently acquired five bronzes of the members of the Hindu Pantheon, which are both of high artistic merit and of interest for their religious significance. The most important of these is a figure of Siva, the Cosmic Dancer, which symbolises God as both performer and audience in the universe as his stage. The figure bears all the marks that are usually attributed to Siva by the Hindus. These figures were found buried near a temple in the Tinnevelly District of the Madras Presidency. They were made by the *cire perdue* process ; and from their stylistic affinities, it is concluded that they belong to the late tenth or early eleventh century of our era. A number of other objects of great interest illustrative of Brahmanical and Buddhist beliefs have been bequeathed to the Museum by Lord Ampthill. —(*Nature*, 1935, **136**, 946.)

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Study of Upper Air Circulation over India.—The Upper Air Section of the Meteorological Office, Poona, have recently published (*India Meteorological Department, Scientific Notes*, 1935, **6**, 66) wind frequencies at 4, 6, 8 and 10 km., prepared out of all available data of morning pilot balloon ascents up to the end of 1931. The data will be of help to investigators of the upper atmospheres and will also meet special aviation requirements such as occurred during the Mount Everest flight in 1933, and the England-Australia Air Race in 1934. It is practically certain that progress in aeronautics will, at no distant date, demand from meteorologists information about upper winds above 3 kms. even for routine flights.

* * *

Report of the Building Research Board for the year 1934. (His Majesty's Stationery Office. Price 3*s.* 6*d.*)—There can be but few problems connected with building that are not at one time or another the subject of scientific investigation at the Building Research Station. The Annual Reports on the Station's activities therefore are invaluable records for those actively concerned with building, whether as architects, engineers, building contractors, manufacturers of materials, etc.

The Station receives a large number of enquiries regarding practical problems annually and an important feature of the reports is a section reviewing the enquiries dealt with during the year.

The Institute of Engineers (India).—The 16th Annual General Meeting of the Institute of Engineers (India) was held in Madras on January 7–8, 1936, with Rao Bahadur B. P. Varma, the President in the Chair. Lt.-Col. (Hon. Col.) F. C. Temple, C.I.E., V.D., was elected President for the current year.

In the course of his Presidential Address, Col. F. C. Temple dwelt on the Teaching of Mathematics; he said "the teaching of applied mathematics in the form of Mechanics, Dynamics, Statics and Hydraulics and Hydro-Dynamics should all be based on practical illustration, because it is supremely important that the Engineer should instinctively and almost subconsciously apply his knowledge to what he sees in front of him or will see when he has carried out into reality whatever he is designing."

A number of important papers were read on January 8, and there was the annual dinner when H. E. Lord Erskine along with other delegates, officials and representatives of trade and commerce were present.

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Economic Conference.—The Nineteenth Session of the Indian Economic Conference was held at Dacca on January 2, 1936, under the presidentship of Mr. Manohar Lal, M.A., Bar-at-Law. In the course of his address, he dwelt upon the present day world economic problems and the various remedies to solve them suggested by different economists. Referring to the problems of Indian Economy, he laid stress on the increasing dependence of India on agriculture and her poor industrial development, which constitutes a grave and fundamental problem, and the inadequacy of Government support to the people. Speaking on the population problem, he cited Japan as an example for India, who by building up her trade and industry effectively solved her population problem. He emphasized the necessity of perfect business organisation and stringent pursuit of sound finance in our trade and industrial policy for building up a sound economy for India. Finally, he sounded a warning note on the fast approaching fate of India maintaining her vast population on her own agriculture and struggling to buy manufactured goods from abroad at growing disadvantage. The most urgent task of the economist now is "to rouse the conscience of both the people and the Government to a consciousness of the peril towards which we are drifting and to the necessity of straining every nerve to reconstruct our economic life", by improvement in agriculture, voluntary restriction on the growth of population, and increase in industrialisation in full view of the situation in the West.

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Roads Congress.—The Second Session of the Indian Roads Congress held its Council Meeting on January 4, 1936, at the Legislative Council Hall, Bangalore, to frame a report to the Congress. Delegates from the various Indian States, Provinces, Government of India and private Engineering firms were present. Mr. K. G. Mitchell was President of the Conference.

The period from 5th to 8th January 1936 was fully occupied by the delegates in inspecting the various Engineering constructions in Bangalore, Mandya, the Tunnel Works at Hulikere, Krishnarajasagar Dam, Sivasamudram and other places of interest near Mysore. Sir Mirza M. Ismail, Kt., C.I.E., K.C.I.E., Dewan of Mysore, formally opened the Congress at Sir Puttanna Chetty Town Hall on the 9th January at 10 A.M. For three days, the delegates were busy with discussions of technical papers and the Business Session which was held on the 11th. During the spare hours on these days, they visited the Indian Institute of Science, Porcelain Factory and the Sandalwood Factory. Some of the delegates then proceeded to Kolar Gold Fields to inspect the mines.

At the preliminary meetings were discussed the Reports of the Technical and Drafting Sub-Committees and the Accounts of the Inaugural Indian Roads Congress.

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The following Sectional Presidents for the Annual Meeting of the British Association to be held in Blackpool from September 9 to 16, 1936, under the presidency of Sir Josiah Stamp, have been appointed:—Mathematics and Physical Sciences: Prof. A. Ferguson; Chemistry: Prof. J. C. Philip, F.R.S.; Economic Science and Statistics: Dr. C. R. Fay; Engineering: Prof. W. Cramp; Agriculture: Prof. J. Hendrick.

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The Royal Society.—At the anniversary meeting of the Royal Society held on Saturday, November 30, 1935, the following officers and members of council were elected:—*President:* Sir William Henry Bragg; *Treasurer:* Sir Henry George Lyons; *Secretaries:* Sir Frank Edward Smith, Prof. Archibald Vivian Hill; *Foreign Secretary:* Prof. Albert Charles Seward; *Other Members of the Council:* Prof. Edgar Douglas Adrian, Mr. David Leonard Chapman, Prof. Arthur William Conway, Dr. William Henry Eccles, Prof. Arthur Stewart Eve, Prof. Louis Napoleon George Filon, Dr. James Gray, Sir Alfred Daniel Hall, Dr. Stanley Wells Kemp, Sir Patrick Playfair Laidlaw, Sir Gerald Ponsonby Lenox-Conyngham, Dr. Gilbert Thomas Morgan, Prof. Robert Robinson, Dr. Bernard Smith, Prof. Walter Stiles, Mr. Wilfred Trotter.

Sir Frederick Gowland Hopkins, President of the Society, then presented the following medals for 1935:—*Copley Medal* to Prof. C. T. R. Wilson for his contributions to the progress of modern physics by his work on the use of clouds in advancing our knowledge of atoms and their properties; *A Royal Medal* to Prof. C. G. Darwin for his researches in mathematical physics, especially quantum-mechanics, optics and statistical mechanics; *A Royal Medal* to Dr. Alfred Harker as the greatest British petrologist since that subject became a science; *Davy Medal* to Prof. Arthur Harden in recognition of his distinguished work in biochemistry and especially of his fundamental discoveries in the chemistry of alcoholic fermentation; and the *Hughes Medal* to Dr. Clinton Joseph Davisson for his discovery that electrons are diffracted like waves of light.

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Asiatic Society of Bengal.—At the ordinary monthly meeting of the Society held on the 6th January, the following candidates were balloted for as ordinary members: (1) Lieut.-Col. Owen C. Pulley, (2) Dr. Owen Alfred Rowland Berkeley-Hill, (3) His Excellency the Rt. Hon'ble Sir John Anderson, and (4) Dr. Alfred G. Brocke.

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Stratosphere Pictures of the Earth.—During the recent record-breaking stratosphere flight over

South Dakota by Captain Albert Steven of the American Army Air Corps, a picture of the earth taken 14 miles above the world's surface has been put forward as a new proof of the earth's roundness. Still and motion pictures at 72,395 feet have been taken. The earth curvature picture shows a section of the horizon, 220 miles long, over 3¼ degrees of circle, about 1/100th part of the total circumference of the earth. Still and motion pictures taken directly downwards from the stratosphere balloon, show the earth as a huge plain, marked with tiny chess board farms and fields, which details were invisible to the naked eye in the balloon.

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The 200-inch glass intended for the giant American telescope was recently taken out of the mould and taken by a special train from Pasadena (California) for polishing. 20 tons of a special kind of silicate glass has been used for making it, and the molten glass was poured into the mould just a year ago. The cooling process has been officially pronounced a success. The polishing operation is expected to take five years. The new telescope will be twice the size of any other, and it is reckoned that with its aid, it will be possible to scan the regions, 1,200,000,000 light years away!

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Expedition to Mount Everest.—The names of the twelve men who, with Mr. Hugh Ruttledge as their leader, will make the fifth attempt to reach the summit of Mount Everest this year, have been announced. Nine have already participated in the previous expeditions to Mount Everest and eight are expected to be capable of reaching high altitudes, up to at least 23,000 feet. The party has been, after a detailed and rigorous examination, limited to twelve to reduce the difficulties of porterage on the glaciers and to simplify the problems of control. The names of the twelve persons selected are: Hugh Ruttledge, F. S. Smythe, E. E. Shipton, P. Wyn Harris, E. G. H. Kempson, Dr. C. B. Warren, F. H. L. Wigram, Lieut. J. M. L. Gavin, Lieut. P. R. Oliver, Major C. J. Morris, Dr. Noel Humphreys and Lieut. W. R. Smirth-Windham.

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Researches conducted jointly by the Antarctic ship, "*Discovery*", the British Museum of Natural History and the London National Institute for Medical Research, show that a female sex hormone, known as progestin, and widely used in gynæcological practice, can be obtained as a by-product of the whaling industry instead of from sows killed in slaughter houses. The hormone, surprisingly enough, can be obtained under ordinary whaling conditions and can be preserved in formalin for many months. Authorities in London believe that the hormone can be produced synthetically on a commercial basis. Progestin is produced by the corpora lutea of the ovaries. Besides playing a secondary sex-stimulating rôle, it prepares the uterus for reception of the fertilised egg preparatory to pregnancy.— (*Science*, 14th Nov. 1935, *Supp.* 10.)

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A Brief History of Self-Reciprocal Functions (*The Journal of the Indian Mathematical Society*, New Series, Vol. 1, No. 7).—Brij Mohan Mehrotra's paper serves as an explanatory introduction to the author's papers on Self-Reciprocal Functions published in various journals. Examples of self-reciprocal functions occurring in the works of various mathematicians are cited. An epitome of the results of Hardy and Titchmarsh, and of Bailey on the subject is then given. The paper concludes with a useful bibliography on the subject.

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Village Sanitation and the Borehole Latrine.—Considerable doubt is being thrown on the practical utility of the Borehole latrine as a safe and convenient method of improving the sanitation of villages in India, a method about which much was expected at one time. *The Allahabad Farmer*, Vol. 9, No. 6, reports an interesting discussion at a meeting of practical rural improvement workers on some of the aspects of this method. How near the water-level is a borehole latrine safe? How near to a well can a latrine be made? How can we arrange for the periodical cleaning of the hole? The nature of the movement of soil moisture both laterally and vertically underground, the possibility or otherwise of bacterial contamination and the safety limits of distance for such have still to be studied and worked out before a satisfactory answer can be given to these questions, data from Egypt or the U. S. A. on these matters not being strictly applicable here. The study of the movements of soil moisture undertaken some years ago in Bangalore certainly indicate that there is a large lateral movement in addition to the vertical movement. Now that the matter has assumed importance from a sanitary point of view in addition to its agricultural aspect, the movement of the bacterial flora, if any, will have to be studied.

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Imperial Institute of Agricultural Research.—It is learnt that Lord Linlithgow will be requested to perform the opening ceremony of the Imperial Agricultural Research Institute in its new home, close to New Delhi, early in November 1936. The Foundation Stone was laid by H. E. Lord Willingdon in February last, and the construction was taken in hand after May. The various buildings for the different sections of research will be ready by the middle of summer. It is estimated that the total cost of the buildings amount to Rs. 36 lakhs. The buildings for the Institute, Library, Laboratory, Officers' quarters, etc., occupy 300 acres and 500 acres are reserved for field experiments.

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A New Fertilizer.—It is reported that, after a series of experiments, a new fertiliser known as Nitrogen Lime Phosphate has been introduced on the German market. It contains about 16 per cent. of Nitrogen (Nitrate Nitrogen and Ammonia Nitrogen in the ratio of 1 : 1), about 16 per cent. of citrate-soluble phosphoric acid and about 35 per cent. of lime in the form of both phosphate and silicate. Due to its great solubility, the new material is stated to give good results both as a top-dressing and as a sub-surface fertiliser. The silicates of lime which are present in it in the form of furnace slag are reputed to cause increase of the rigidity of the grain grown and to act as preventive to the growth of fungus.

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The Preservation of Oxidisable Products.—Highly protective yellow transparent cellulose films have been developed in the United States for the protection against rancidity of foodstuffs

and other organic bodies. It has been established by systematic exposure tests that the blue and invisible portions of the Solar spectrum are the main accelerators of rancidity, and that many of the coloured transparent wraps that have been introduced hitherto have failed in their purpose in that they did not completely filter out the blue and ultra-violet radiations. The new product in sheeting 0.001-inch thickness is claimed as being completely opaque to ultra-violet light while possessing a very high transparency. The utilisation of the sheeting is also proposed for preventing the decomposition of hydrogen peroxide, and for avoiding the discolouration of such products as phenol, aniline oil, quinine sulphate and calomel. It is also suggested that it can be used as a wrapping material for packaged flavours, perfumes and toilet soaps.—(*The Chem. Trade Jour. and Chem. Engineer*, 1935, **97**, 470.)

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The Symons Gold Medal for 1936 of the Royal Meteorological Society has been awarded to Prof Wilhelm Schmidt, Director of the Central Institution for Meteorology and Geodynamics, Vienna. This medal is awarded biennially in recognition of distinguished work in the field of meteorological science.

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The Perkin Medal has been awarded to Dr. Warren K. Lewis of the Massachussets Institute of Technology. The medal is awarded annually for outstanding work in applied chemistry.

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The Permanent International Committee of Congresses of Genetics, which was constituted at the Sixth International Congress of Genetics held at Ithaca, New York, 1932, has accepted the invitation of the Academy of Sciences of the U. S. S. R. to hold the Seventh International Congress in Moscow and Leningrad in 1937. At about the same time, the All-Union Agricultural Exhibition will be held in Moscow thus making the occasion unique.

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The 12th International Acetylene Congress will be held at Caxton Hall, Westminster in June 1936. H. R. H. the Prince of Wales has consented to lend his name as Patron of the Congress. Dr. J. Donald Pollock and Mr. P. B. Liversidge of the British Oxygen Company, Ltd., have accepted the offices of President and Vice-President respectively. Further information may be obtained from the General Secretary, 12th International Acetylene Congress, 639, Grand Buildings, Trafalgar Square, London, W. C. 2.

* * *

It is announced in *Science* that the date of the third International Congress on Malaria has been postponed until the spring of 1936. Further information can be had from Prof. G. Pittaluga, Director of the National Institute of Health, Calle de Recoletos, 20, Madrid.

* * *

The International Union of Geodesy and Geophysics will meet at the University of Edinburgh from September 15 to 26, 1936.

* * *

It is announced in *Nature* that the fourth International Congress of Cytology will be held in Copenhagen in 1936, probably in August. Further information can be had from the General Secretary, Nassaustrasse 17, Berlin-Wilmersdorf.

The first International Congress of Criminal Anthropology and Psychiatry will be held in Rome in April 1936. Etiology, diagnosis and prognosis of criminality in minors; prophylaxis of crime in relation to penal laws; criminal biology and anthropology, etc., will be some of the subjects to be discussed. Further information can be obtained from the General Secretary, Prof. B. di Tullio, via Giulia 52, Rome.

* * *

Recent Publications.—Scripta Mathematica Library: "Poetry of Mathematics and Other Essays," by Professor David Eugene Smith. 96 pages. Price 75 cents. "Mathematics and the Question of Cosmic Mind, with Other Essays," by Professor Cassius Jackson Keyser. 128 pages. Price 75 cents. "Mind, the Maker: The World Theory of the late William Benjamin Smith." Presented by Professor Cassius Jackson Keyser. 32 pages. Price 35 cents.

* * *

It is announced that the third International Congress of Comparative Pathology will be held in Athens from April 15 to 18, 1936, under the presidentship of Prof. W. Bensis of Paris.

* * *

ANNOUNCEMENTS.

Third Course of Instruction in Malariology.—The Health Committee of the League of Nations is arranging for a Third Course of Instruction in Malariology which will commence at the King Edward VII College of Medicine at Singapore on 27th April.

There will be three distinct stages to each course.—(1) A preliminary revision course for 4 days from 22nd April 1936, for candidates with a limited experience of the subject; (2) Theoretical and laboratory studies with practical demonstrations lasting from 27th April to 30th May; and (3) The practical field studies commencing at the beginning of June, for which the candidates will be divided into groups, one of which will study in Malaya, one in French Indo-China and probably another in Java. This occupies about 21 days by which time the students are expected to become familiar with the routine of a malariologist and the actual application of anti-larval and other anti-malarial measures to field conditions.

The League of Nations is making available a limited number of partial fellowships to candidates nominated by their Governments on condition that their Governments bear half the cost. The subscription for the theoretical and laboratory course will be 75 Straits dollars. Any further information will be supplied by the Director of the Eastern Bureau of the League of Nations, 336, River Valley Road, Singapore. Applications for admissions should be addressed to the above address so as to reach Singapore before 29th February 1936 and as only 30 candidates are admitted, early application would be advantageous.

* * *

Reward of £ 5,000 for a Practicable Method of Eradicating Skeleton Weed.—The following taken from the *Agricultural Gazette of New South Wales, Australia*, Vol. 46, Pt. 7, will be found interesting and, let us hope, profitable to readers of *Current Science*. A reward of £ 5,000 is being offered for a practicable method—mechanical, cultural, biological or chemical—of completely eradicating mature and seedling plants of Skeleton Weed.

The offer is subject to a number of terms and conditions, which can be obtained from the Department of Agriculture. The suitability, practicability and efficacy of any method submitted and the question whether the prescribed conditions have been complied with shall be determined by a committee which shall be appointed by the Minister for Agriculture, whose decision shall be final. Applications for the reward will be received by the Minister for Agriculture, up till 1st July 1937.

We may add that the botanical name for what is called "skeleton weed" in the above is *Chondrilla juncea*. The characters of the plant appear various and it is known under a number of specific names such as *C. lacinata*, *C. intybacea*, *C. lutea*, *C. latifolia*, *C. viscosa*, *C. rigens*, and so on.

While on this subject we may also remind readers that a similar reward awaits nearer home, *viz.*, the reward promised by the Government of Mysore for a suitable remedy for the spike disease of sandal announced some twenty-five years ago which, so far as we know, has not been withdrawn nor been claimed and won by anyone.

* * *

We acknowledge with thanks the receipt of the following :—

"Agricultural Gazette of New South Wales," Vol. XLVI, Pt. 12.

"Journal of Agricultural Research," Vol. 51, No. 4.

"Journal of Agriculture and Livestock in India," Vol. V, Pt. VI, November 1935.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4331–4333.

"Indian Journal of Agricultural Science," Vol. V, Pt. V, October 1935.

"Journal of the Annamalai University," Vol. V, No. 1, November 1935.

"Biochemical Journal," Vol. 29, No. 11, November 1935.

"The Journal of the Indian Botanical Society," Vol. 15, No. 1, January 1936.

"The Journal of the Institute of Brewing," Vol. XLI, No. 12, December 1935.

"Canadian Journal of Research," Vol. 13, Nos. 4 and 5.

"Chemical Age," Vol. 33, Nos. 856–859.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 12.

"The Journal of the Indian Chemical Society," Vol. 12, No. 11, November 1935.

"Forschungen und Fortschritte," Vol. 11, Nos. 34, 35, 36.

"Monthly Statistics of the Production of Certain Selected Industries of India," July and August 1935. (Department of Commercial Intelligence and Statistics, India.)

"The Philippine Agriculturist," Vol. 24, Nos. 1 to 7.

"Scientific American," Vol. 153, Nos. 5 and 6.

"The Review of Applied Mycology," Vol. 14, Pts. 2–11.

"Transactions of the Faraday Society," Vol. 31, Pt. 12, December 1935.

"Report No. 12 from the Fisheries and Marine Biological Survey for the year ending December 1934," South Africa.

"Quarterly Bulletin of the Health Organization," Vol. 4, No. 3, September 1935. (League of Nations, Geneva.)

"Department of Commerce and Industries—Fisheries and Marine Biological Survey Division, South Africa, Investigational Report," No. 5.

Indian Central Cotton Committee Technological Laboratory, Technical Leaflet No. 5, November 1935.—"The Influence of Method of Picking on the Quality of Cambodia Cotton."

"The Lenin Academy of Agricultural Sciences in U.S.S.R.," August 1935.

"Marriage Hygiene," Vol. II, No. II, November 1935.

The Punjab Irrigation Research Institute—"Report for the year ending April 1935."

"Nature," Vol. 136, Nos. 3447–3450.

"The Journal of the Bombay Natural History," Vol. 38, No. 2, Index and Title-page, Vol. 37, Nos. 3 and 4.

"The Journal of Nutrition," Vol. 10, No. 5.

"Journal de Chimie Physique," Vol. 32, No. 9.

"The Indian Trade Journal," Vol. CXIX, Nos. 1540–1541.

CATALOGUES.

"Catalogue of Books of Messrs. John H. Knowles on Agriculture, Botany and Zoology," No. 22, 1935.

"Neuere Chemische und Physikalische Werke," November 1935.

"Verzeichnis der Werke und Zeitschriften" (Akademischen Verlagsgesellschaft, M.b.H., Leipzig).

Indian Obstetric and Gynæcological Congress.

THE first All-India Obstetric and Gynæcological Congress was held at Madras on the 2nd, 3rd and 4th January 1936, under the distinguished presidency of Dr. Ida Scudder, M.D., D.Sc., F.A.C.S. His Excellency Lord Erskine, G.C.I.E., the Governer of Madras, inaugurated the session. Rao Bahadur Dr. A. Lakshmanaswami Mudaliar, M.D., F.C.O.G., Chairman of the Reception Committee, extended a very hearty welcome to the vast and representative assemblage of delegates to the Congress.

Being the first sessions of the Congress a greater portion of the Presidential Address naturally dealt with its aims. The President said "As an outcome of this Congress," which is a fruition of the conjoint efforts of the Bombay Obstetrical Society and the Obstetrical and Gynæcological Society of Madras and S. India, "research should be stimulated and with this end in view we should encourage the establishment of an Indian Obstetrical and Gynæcological Journal ....." The President then proceeded to discuss methods of coping with the many-sided obstetric problem of the Indian villages a subject which he has pursued with ardour for over three decades. The large infantile and maternal mortality to which His Excellency adverted in his inaugural speech, was greatly due to the ignorance of the lay public that needed education to avail of the modern methods of obstetrical practice. In this direction the young medical practitioner had a duty to perform in

disseminating knowledge amongst and bringing relief to the superstitious and suffering villagers. There would thus arise the necessity for the establishment of a central organisation with powers to control and supervise all obstetric and gynæcological work in the country. Such an organisation, with the co-operation of the different Local Bodies, would alone lead to rural upliftment in maternity and child-welfare.

In the welcome address, delivered earlier by the Chairman of the Reception Committee greater emphasis was, however, laid on the need for research in our country in obstetrical and allied problems. And, as for the means to carry on such research, the Chairman remarked, "May we not hope that an appeal from this Congress and through Your Excellency to the generous public will not fail to evoke a sympathetic response? May we not also hope that various administrations in British India and Indian India will co-operate in a spirit of healthy rivalry to organise and support all such laudable enterprise?"

About fifteen papers pertaining to obstetrics and gynæcology were read and discussed during the session. Of these, the papers read on the last day were particularly interesting devoted, as they were, mostly to problems of post and antinatal care, causes and prevention of infantile mortality, and of child-welfare in general. There were two debates, one on "Pelvic Disproportions" and the other on "Displacements of the uterus". Mrs. Margaret Sanger gave an evening lecture on "Contraception".

A noteworthy feature of this Congress was an exhibition, displaying medical and surgical goods used in obstetrical and gynæcological practice, infant foods and milk products, patent medicines and drugs.

A tea and a dinner and visits to the different hospitals of Madras formed the social functions of the Congress.

At the business sessions of the All-India Obstetric and Gynæcological Congress, it was resolved that the Congress should be a biennial one, and at the invitation of the Bombay Obstetric Society, the next session is proposed to be held in Bombay in December 1937. It was also resolved that provincial Obstetric and Gynæcological societies should be formed in Bengal, and if provincial organisations were not possible, two or three Provinces may possibly join together and form a central association, as the Northern India Obstetric and Gynæcological Association, or the Central India Association. The States of Mysore, Hyderabad, Travancore, Cochin and Pudukottah, it was felt, should be included in the Obstetric Association of Southern India.

The question of the publication of a Journal in Obstetrics and Gynæcology was deferred consideration till the formation of provincial societies was complete.

At the next Congress, two subjects were included on which a symposium should be prepared and discussion held, *viz.*,

(1) Toxæmias of pregnancy,
(2) Carcinoma of the cervix uteri.

A resolution was also passed urging that the Indian Medical Council should lay down a standard of training in Midwifery for medical students, which should be not less than 6 months of hospital training and the personal conduct of 20 cases of labour.

M. SRINIVASAN.

Indian Institute of Science—Quinquennial Reviewing Committee.

THE Personnel of the Committee has been announced:—

Chairman:

Sir James Colquhoun Irvine, C.B.E., D.Sc., F.R.S.

Members:

Dr. Arthur Henderson Mackenzie, M.A., D.Litt., C.S.I., C.I.E.;

Dr. S. S. Bhatnagar, D.Sc., O.B.E.

Secretary:

Mr. F. F. C. Edmunds, M.A., B.Sc.

Sir James Irvine who is 58 years old, is the Vice-Chancellor and Principal of the St. Andrews University since 1921. He was formerly Professor of Chemistry and Dean of the Faculty of Science in that University; he served on the Advisory Council of the Department of Scientific and Industrial Research, was lately Vice-President of the Royal Society of Edinburgh and is still Chairman of the Forest Products Research Board.

Dr. Arthur Henderson Mackenzie, born February 1880, is the Pro-Vice-Chancellor of the Osmania University. He was Principal, Government Training College, Allahabad 1908-1919 and Chief Inspector of Vernacular Education, 1919-1921. He was appointed Director of Public Instruction, U.P., 1925-1935. He was also a Member of the Legislative Council, U.P., 1922-34, and the officiating Education Commissioner with the Government of India, 1930-31.

Dr. S. S. Bhatnagar who was recently honoured with the title of O.B.E., is the University Professor of Physical Chemistry and Director of Chemical Laboratories, University of Punjab. He is well known for his researches on Magneto-Chemistry, and is the author of a standard work 'Physical Principles and Applications of Magneto-Chemistry' (Macmillan & Co., London, 1935).

Mr. F. F. C. Edmunds, Inspector of Schools, Coorg and Bangalore, was the Secretary of the last Reviewing Committee constituted in 1930.

Academies and Societies.

Indian Academy of Sciences :

December 1935. SECTION A.—MAX BORN : *The Mysterious Number* 137.—Using electronic units all laws of atomic physics become dimensionless equations with numerical coefficients. These coefficients are not all purely mathematical numbers, but amongst them appears the Sommerfeld fine structure constant $\alpha \left(= \frac{e^2}{\hbar c} \right)$ whose reciprocal is 137. This high value of $\frac{1}{\alpha}$ is the decisive factor for the order of magnitudes of all physical phenomena, when reduced to electronic units. INDER CHOWLA : *Vinogradow's Solution of Waring's Problem. Hypothesis K of Hardy and Littlewood.* B. SANJIVA RAO and K. S. SUBRAMANIAM : *The Occurrence of Furan Derivatives in Volatile Oils. II. α-Clausenan and Di-α-Clausenan.*—The constitution of the clausenans have been further worked up. (LATE) A. N. MELDRUM AND A. S. DATAR : *Reduction of the* —CHOH.CCl_3 *Group.*—The reduction products were found to contain the group $CH_2.CHCl_2$. P. V. SUKHATME : *A Contribution to the Problem of Two Samples.* B. F. FERREIRA AND T. S. WHEELER : *A Study of the Benzoin Reaction-V.*—The effect of inhibitors on the benzoin reaction. The inhibiting actions of sulphur, carbon disulphide, thiobenzaldehyde, iodine and quinine on the reaction between pure benzaldehyde and pure solid potassium cyanide have been studied. C. S. VENKATESWARAN : *The Raman Spectra of Some Formates and the Constitution of Formic Acid.*—Both crystals and aqueous solutions have been studied, the lines at 2831 and 2732 giving direct evidence for the existence of CH group in formic acid. P. NILAKANTAN : *Magnetic Anisotropy of Naturally Occurring Substances.—I.—Mother of Pearl.*—The observations indicate that the *c*-axes of the aragonite crystals are in every case normal to the elementary laminæ. K. L. RAMASWAMY : *Refractive Indices and Dispersions of Volatile Compounds of Fluorine and Boron.*—By comparing with the corresponding dielectric polarisations, it is found that the fluorine compounds and the complex compound of Boron $B_3N_3H_6$ have appreciable values of atomic polarisations. B. G. ACHARYA AND T. S. WHEELER : *Detergency of Soap Solutions.*—The adsorption of soap by cotton under standard conditions may be a measure of the detergent action of soap solutions. V. I. VAIDHIANATHAN, GURDAS RAM, AND E. MCKENZIE TAYLOR : *Uplift Pressure on Weirs.*—A Floor with a line of sheet piles.

December 1935. SECTION B.—M. MITRA AND K. F. KHESWALLA : *The Effect of Temperature on the Growth of* Fusarium vasinfectum *Atk.*—The influence of temperature on the growth of *Fusarium vasinfectum* Atkinson causing the wilt diseases of cotton in Western India has been studied. COL. I. FROILANO DE MELLO : *New Trypanosomids of Some Indian Birds.*—Some new trypanosomes of the Indian birds are recorded. M. B. MIRZA AND S. S. NARAYAN : *Strongyloides akbari N. Sp. A New Nematode Parasite from* Crocidura coerulea, *with a Note on Some Species of the Genus Strongyloides.*—A new species of *Strongyloides* from *Crocidura coerulea* has been described. For the first time, *Strongyloides* is recorded as a parasite of reptiles. The occurrence of a new variety of *Strongyloides stercoralis* in fox has also been noted. G. N. RANGASWAMI AYYANGAR, V. PANDURANGA RAO AND A. KUNHIKORAN NAMBIAR : *The Inheritance of Some Characters in Crosses with the Sorghums, Milo and Kafir.*—Data on the inheritances of a few characters from a cross between Blackhull Kafir (*Sorghum caffrarum*, Beauv.) and Dwarf Yellow Milo (*Sorghum caudatum* Stapf.) are presented. A. C. JOSHI AND J. VENKATESWARLU : *Embryological Studies in the Lythraceæ II.* Lagerstræmia *Linn.*—The structure and development of the ovule and embryo-sac in two species of *Lagerstræmia*, namely, *L. indica* Linn. and *L. Flos-Reginæ* Retz. have been described. C. BHASHYAKARLA RAO : *A New Species of* Stichosiphon (Stichosiphon indica *Sp. Nov.*).—The alga found growing as an epiphyte on species of *Cladophora* and *Lyngbya* has been described as a new species of the genus *Stichosiphon* Geitler, and named *Stichosiphon indica* Sp. Nov.

FIRST ANNUAL MEETING.

18th, 19th, 20th and 21st December 1935.—THE FIRST ANNUAL MEETING was held at the Royal Institute of Science, Bombay. His Excellency the Governor of Bombay, inaugurated the meeting. The proceedings of the meeting were broadcast.

Rajasabhabhushana Sir C. V. Raman, KT., F.R.S., N.L., the President of the Academy, in the course of his address, reviewed the progress of the Academy since its foundation. The scientific activities can be considered under three heads : (1) Meetings for discussion of research papers, (2) Symposia on special subjects, and (3) Publication of Proceedings. The President referred to the generous personal gift by His Highness the Maharaja of Mysore, of ten acres of land in the vicinity of the Indian Institute of Science, as a permanent location for the Academy. The location is a historic spot close to one of the four towers set up by Kempe Gowda, a former Hindu ruler, as a limit for the extension of his city. A relief map shows this site to be the highest spot in Bangalore.

A symposium on colloids and sectional meetings were held. Two public lectures, one on "The Human Eye" by Dr. B. K. Narayana Rao, and the other on "Sounds that cannot be heard" by Sir C. V. Raman, were arranged. Several excursions were also included in the 4-day programme of the Session.

The following members constitute the Council for the year 1936 :—

President : Rajasabhabhushana Sir C. V. Raman, KT., F.R.S., N.L.

Vice-Presidents : Dr. E. P. Metcalfe ; Dr. Birbal Sahni ; Dr. B. K. Singh ; Dr. T. S. Wheeler.

Secretaries : Prof. C. R. Narayan Rao ; Rao Bahadur Prof. B. Venkatesachar.

Treasurer : Dr. V. Subrahmanyan.

Members of Council : Dr. S. K. Banerji ; Major S. L. Bhatia ; Dr. S. S. Bhatnagar ; Dr. S. Chowla ; Dr. R. B. Forster ; Prof. K. S. Krishnan ; Dr. G. Mathai ; Dr. B. K. Narayana Rao ; Dr. Nazir Ahmed ; Dr. K. R. Ramanathan ; Prof. L. Rama Rao ; Dr. M. R. Sahni ; Dr. M. A. Sampathkumaran ; Dr. S. Subba Rao ; Sir M. Visvesvaraya,

The Academy of Sciences, U.P.:

December 1935. M. S. DESAI: *The Study of Absorption Spectra of Lead Fluoride.* N. L. PAL: *Hydrogen Ion Concentration and Titratable Acidity at Different Stages of Fruit Ripening.* B. S. SRIKANTAN AND S. RANGACHARI: *Utilisation of Waste Vegetation. I.—Gasification of Prickly Pear* (Opuntia Dillinii). D. S. KOTHARI AND R. C. MAZUMDAR: *The Quantum Statistics and the Internal Constitution of the Planets.* M. N. SAHA AND L. S. MATHUR: *A Critical review of the Current Theories of the Active Nitrogen Phenomenon.* —A new modification of the theory of Saha and Sur, formulated ten years ago, has now been proposed, and the authors have suggested experiments to verify the theory. SATYENDRA RAY: *On Sulaiman's Single Journey Method.*—A criticism of Chapter VII, Section 1 of "Mathematical Theory of a New Relativity" of Sulaiman.

FIFTH ANNUAL MEETING.

December 19, 1935. FIFTH ANNUAL MEETING.—His Excellency Sir Harry Graham Haig, K.C.S.I., the Patron of the Academy, presided.

Prof. N. R. Dhar, President of the Academy, delivered an address on "A new method of nitrogen fixation and conservation, and reclamation of Alkali Lands". In the course of his address, Prof. Dhar pointed out that while the Indian soils, generally speaking, contain sufficient quantities of potash, lime, phosphate and other necessary plant food materials, they are very deficient in nitrogen, containing as they do approximately 0.04 per cent. as against 0.1 per cent. present in the soils of European and other cold countries. By adding molasses to the soil in heaps and ensuring conditions for proper aeration, an increase of over a hundred per cent. in soil nitrogen has been effected. The beneficial effect of crop yields as a result of the application of molasses is seen from the fact that with paddy, an yield of 14.5 maunds per acre as against 8.1 maunds per acre in the control fields has been recorded; an increased yield of 40 per cent. has been obtained with sugarcane. Molasses should be added 2 to 3 months before sowing the crop, the soil, after application, being ploughed 3 or 4 times.

The application of molasses with ammonium sulphate, leads to the conservation of nitrogen, as shown by the fact that the nitrogen content of the molassed soil is always greater than that of the controls where ammonium sulphate alone has been added. A mixture of molasses and ammonium sulphate is thus a better fertilizer than ammonium sulphate alone.

The reclamation of alkali soils can be effected by the application of molasses. The lime which is contained in the molasses, is rendered soluble by the organic acids formed during the decomposition and replaces the sodium of the alkali soils. The tilth of the soil is greatly improved. Alkali lands have been successfully reclaimed in different parts of the U.P. and Mysore by the application of molasses.

His Excellency Sir Harry Haig, K.C.S.I., in the course of his speech referred to the interesting results of Prof. Dhar's work and said that "it is necessary for the local Government to examine most carefully the economics of their application to practical agriculture",

Members of the Council and Officers of the National Academy of Sciences for the year 1936:—

President: Prof. N. R. Dhar, D.Sc., F.I.S., I.E.S.

Vice-Presidents: Prof. K. N. Bahl, D.Phil. (Oxon.), D.Sc., (Punjab); Prof. A. C. Banerji, M.A. (Cantab.), M.Sc., (Cal.), F.R.A.S. (Eng.), I.E.S.

Hon. Treasurer: Dr. H. R. Mehra, Ph.D.

General Secretaries: Dr. S. M. Sane, B.Sc., Ph.D.; Dr. P. L. Srivastava, M.A., D.Phil. (Oxon.).

Foreign Secretary: Prof. B. Sahni, D.Sc. (Lond.)

Other Members of the Council: Prof. K. C. Mehta, Ph.D. (Cantab.), M.Sc. (Punjab); Prof. M. N. Saha, D.Sc., F.R.S.; Prof. S. S. Bhatnagar, D.Sc; Prof. Ch. Wali Mohammad, M.A., Ph.D. (Gottingen), I.E.S.; Dr. Shri Ranjan, M.Sc., D.Sc. (Toulouse); I.t.-Col. R. N. Chopra, C.I.E., M.B., I.M.S.; Dr. C. W. B. Normand, D.Sc., M.A.; Prof. D. R. Bhattacharya, D.Sc., Ph.D., F.Z.S.; Prof. P. K. Parija, M.A. (Cantab.), B.Sc. (Cal.)

Announcement.

The Education Minister's Gold Medal has been awarded to Dr. Sikhibhushan Dutt, D.Sc. (Lond.), Chemistry Department, Allahabad University, Allahabad, his papers having been judged to be the best published on 'Chemistry and Technology' in the *Journal of the Academy.*

The National Institute of Sciences of India:

January 4, 1936.—THE ANNUAL MEETING of the National Institute of Sciences of India was held on Saturday, at the Daly College, Indore, with Sir Lewis Fermor, President of the Institute, in the Chair.

Presidential Address:

THE CORRELATION OF ARCHÆAN ROCKS.

"We geologists do not practise a Science enclosed in a water-tight compartment. We are dependent at every step upon other Scientists. Thus we rely upon help from the Physicists and Chemists in the determination of the Physical Constants and the Chemical Composition of minerals and rocks, in the solution of the problems of Seismology and Geophysics, and in the determinations of the Radio-Active Constants of minerals and rocks; to the Botanist and Zoologist, we look for help in understanding the relationships of the organisms now represented by Fossils; we join with the Astronomer when we pursue our Geology back to the earliest history of our globe and contemplate the relationship of our earth to other Stellar bodies.... Geology is, in a way, the Science that synthesises all others, as it is the Science of the Earth upon which we live. The Geologist is therefore often able to provide a check to other Sciences, and to help with suggestions for research."—thus said Dr. Sir Lewis L. Fermor in the concluding part of the Address. In this valuable address, Dr. Fermor gives a brief review of the several methods used in the Correlation of Archæan rocks. After giving a lucid preliminary account of the general problem of stratigraphical correlation, he proceeds to point out that, difficult as is this general problem, the special problem provided by the Archæan rocks is incomparably more difficult—in view of the totally unfossiliferous character of these rocks and the intense metamorphism to which they have been subjected. There are, however, certain criteria available for the correlation of Archæan rocks; but it must be remembered that none of these are constantly available, but that by taking account of this criterion in one

case and that in another, one may expect to succeed in effecting a certain degree of correlation. After enumerating the following available criteria—

(1) Stratigraphical Sequence and Continuity. (2) Structural relationships, *e.g.*, Presence of unconformities and relationship to periods of folding. (3) Relationship to igneous intrusives. (4) Associated ore-deposits of epigenetic origin. (5) Lithological Composition. (6) Chemical Composition. (7) Grade of Metamorphism. (8) Uranium-Lead Ratios and Thorium-Lead Ratios.

Dr. Fermor has touched briefly on each of these as illustrated by definite examples derived from the Archæan terrane of Peninsular India—a field of study in which he can certainly speak with authority. In connection with the first criterion, for instance, it has been pointed out how the recognition of the Sausar series has helped in the complete unravelling of the Archæan Stratigraphy from Sausar to Balaghat in the Central Provinces. The value of the study of associated epigenetic ore-deposits in correlation has been illustrated with reference to the gold deposits of Mysore and Singbhum, and the copper deposits of Singbhum and Sikkim. Talking of Lithological Composition as an aid to Correlation, Dr. Fermor has drawn attention to the Gondite series, a careful study of which leads to the reasonable hypothesis that all gonditic rocks in India may be considered as representing a definite stratigraphical horizon, and as such will eventually enable us to correlate the Archæan rocks of Rajputana, the Central Provinces, and Singbhum. In connection with the "Grade of Metamorphism" as a criterion available for use in correlating the Archæan rocks, Dr. Fermor has discussed, at some length, the views of Van Hise, Grukenmann and Niggli, regarding metamorphism in general—in view of the importance of this subject in the study of our Indian Archæan Schists, and then proceeds to point out, with reference to actual examples, that "We must not be led by the presence of a great general difference between the grade of metamorphism in two tracts of country into assuming that they are necessarily of different age, the more highly metamorphosed tract being on this view, the older. Instead, we must be prepared to consider whether the differences may be due, not to difference of age—by which in this case we mean the more prolonged subjection of the more highly metamorphosed tract to metamorphic agencies—but to the metamorphic forces having been applied with different degrees of intensity to rocks of the same age." Lastly, Dr. Fermor refers to the discovery of radio-activity and says, "In this discovery, we are witnessing the fashioning of a new weapon for determining the age of minerals and thus the minimum age of the rocks containing them—a weapon that in the absence of fossils is particularly welcome to students of Pre-Cambrian Geology."

Considering that this address was to be read before a gathering of eminent Scientists representing all branches of knowledge, Dr. Fermor has rightly refrained from making it too abstruse or technical. Here is true "Geology without jargon", and in delivering such a lucid and informing address on a subject of great importance, we have no doubt that Dr. Fermor has done a great service to the study of Indian Geology.

The following papers were read and discussed :

(1) J. A. Dunn. "A Study of Some Microscopical aspects of Indian Manganese Ores."
(2) Dr. Tashkhir Ahmad, "The Influence of Constant and Alternating temperature on the developmental stages of certain insects."
(3) N. K. Saha, "Studies in the Electron Theory of solid metal."
(4) P. C. Mahalanobis, "On the generalised distance in statistics."
(5) Dr. H. S. Rao. "Pearl-like concretions (Calculi) found in the stomach of a shark (*Zygæna blochii*, Cutrer).
(6) S. L. Hora, "Nature of Substratum as an important factor in the ecology of torrential fauna."

The following members constitute the Council of the Academy for the year 1936 :—

President : Sir L. L. Fermor.
Vice-Presidents : Brigadier H. J. Couchman ; Professor B. Sahni.
Treasurer : Dr. S. L. Hora.
Foreign Secretary : Prof. M. N. Saha.
Secretaries : Prof. S. P. Agharkar ; Dr. A. M. Heron.
Members of Council : Mr. M. Afzal Husain : Dr. Baini Prashad ; Mr. T. P. Bhaskara Shastri ; Prof. J. C. Ghosh ; Dr. F. H. Gravely ; Prof. S. S. Bhatnagar ; Sir B. C. Burt ; Lt.-Col. R. Knowles ; Dr. K. S. Krishnan ; Prof. S. K. Mitra ; Prof. J. N. Mukherjee ; Dr. C. W. B. Normand ; Prof. N. R. Sen ; Prof. B. Venkatesachar ; Lt.-Col. S. S. Sokhey ; Lt.-Col. J. A. Sinton ; Mr. C. G. Trevor ; Mr. F. Ware.

Representatives of the Asiatic Society of Bengal :—
Additional Vice-President : Rai Sir U. N. Brahmachari Bahadur.
Additional Member of Council : Mr. C. C. Calder.

Representatives of the U. P. Academy of Sciences :—
Additional Vice-President : Prof. K. N. Bahl.
Additional Member of Council : Prof. A. C. Banerji.

Representatives of the Indian Academy of Sciences :—
Additional Vice-President : Prof. B. K. Singh.
Additional Member of Council : Dr. K. S. Krishnan.

Representatives of the Indian Science Congress Association :—
Additional Vice-President : Dr. J. H. Hutton.
Additional Member of Council : Mr. W. D. West.

Indian Science Congress, 1936 :

At the Annual Meeting of the General Committee of the Indian Science Congress Association held at Indore on January 6th, it was unanimously resolved to celebrate the Silver Jubilee of the Indian Science Congress in January 1938 by inviting a deputation of Scientists from the British Association and elsewhere to join in the meeting.

Officers of the Indian Science Congress, 1937.—GENERAL PRESIDENT: Rao Bahadur T. S. Venkataraman. SECTIONAL PRESIDENTS: (1) *Mathematics and Physics*: Prof. S. Datta, Calcutta; (2) *Chemistry*: Prof. J. N. Ray, Lahore; (3) *Geology and Geography*: Mr. W. D. West, Calcutta; (4) *Botany*: Mr. H. G. Champion, Dehra Dun; (5) *Zoology*: Dr. G. S. Thapar, Lucknow; (6) *Anthropology*: Dewan Bahadur Dr. L. K. Ananthakrishna Ayyar, Paighat; (7) *Agriculture*: Rao Bahadur B. V. Nath, Pusa; (8) *Medical and Veterinary Science*: Col. Oliver, Delhi; (9) *Physiology*: Dr. B. L. Bhatia, Bombay; (10) *Psychology*: Dr. K. C. Mukherji, Dacca.

Venue of the Congress—Hyderabad.

Indian Physical Society:

An extraordinary meeting of the Indian Physical Society was held at 4 P.M. on the 13th December 1935, in the Applied Physics Seminar, University College of Science, Calcutta.

Recommendations of the Council for changes in the Rules of the Society were considered and accepted without division. Besides making minor changes, the Council has been enlarged, and will, under the new rules, consist of a President, four Vice-Presidents, the Secretary, the Treasurer and twelve more members, in place of a President, two Vice-Presidents, the General Secretary, the Treasurer and six members.

Following the extraordinary meeting the ninth ordinary meeting of the Society was held at the same place, when the following papers were read:—

(1) "On the Wing accompanying the Rayleigh Line in Liquid Mixtures" by Dr. S. C. Sirkar.

(2) "Studies on Paramagnetism independent of Temperature, Part I" by Dr. D. P. Ray Chaudhuri, D.Sc., and Mr. P. N. Sen Gupta, M.Sc.

(3) "Effect of Magnetic Field on the Viscosity of Liquids, Part II" by Mr. S. D. Chatterjee.

Indian Chemical Society:

November 1935. PRAFULLA KUMAR BOSE AND SUNDAR RAM: *On the colour reaction of certain nitro compounds.* NRIPENDRA NATH CHATTERJEE: *Studies in Diphenyl series. Part IV.—Action of Oxalyl Chloride on Diphenyl Derivatives.* TEJENDRA NATH GHOSH: *Extension of Michael's Reaction. Part V.* R. N. AGARWALA AND D. C. MANDEVILLE: *The Electrical Conductivity of Potassium Chloride in certain mixed solvents.* JOSEPH W. H. LUGG: *Note on the anomalous redox potentials of sulphhydryl-disulphide systems.* BALWANT SINGH AND RADHA KRISHEN: *Parachor and Chemical Constitution. Part VI.—Quadrivalent Tellurium Compounds.* M. GOSWAMI, H. N. DAS-GUPTA AND K. L. RAY: *Analytical uses of Nessler's Reagent. Detection of Aldehydes. Quantitative Estimation of Glucose. Part I.* DINAKAR KARVE AND KRISHNAJI KHANDO DOLE: *Kinetics of Reactions in Heterogeneous Systems. Part I.—The Reaction between Carbon Disulphide and Alkali.* DINAKAR KARVE AND KRISHNAJI KHANDO DOLE: *Kinetics of Reactions in Heterogeneous Systems. Part II.—The Reaction between Benzoyl Chloride and Water.* SOBHANLAL BANERJEE AND H. K. SEN: *Effect of Ultra-violet Light on Enzymatic Reactions. Part II.—Pepsin.* P. C. MITTER AND SHYAMAKANTA DE: *Condensation of Succinic Anhydride with Phenols and Phenolic Ethers. Synthesis of Derivatives of tetrahydronaphthalene. A Preliminary Note.* DHIRENDRA MOHAN MUKHERJEE: *Methyl-Red as an adsorption indicator.*

A Note.—An Ordinary Meeting of the Society was held on Thursday, 5th December 1935, at the University College of Science, Calcutta, Dr. J. N. Mukherjee presided. The following were admitted as Fellows of the Society: Prof. Jamiat V. Lakhani, M.Sc., Ph.D., D.I., Sind College, Karachi; Sudhansu Sekhar Ghosh, Esq., M.Sc., University Chemical Laboratories, Lahore; and R. C. Srivastava, Esq., B.Sc., Sugar Technologist, Imperial Council of Agricultural Research, Cawnpore.

Dr. P. B. Sarkar delivered a lecture on "The Constitution of the Diazo Compounds from the standpoint of Electronic Theory of Valency."

Indian Botanical Society:

January 1936. P. S. GUPTA: *The Effect of Edaphic Conditions on the Ecological Anatomy of Certain Species.* KALI KINKAR SAMAL: *The Development of the Embryo-Sac and Embryo in* Crotalaria juncea *L.* H. CHAUDHURI: *A Scheme for the Dissemination of the Knowledge of Plant Disease in India and Suggestions for Control of Diseases.* D. P. MULLAN: *On the Anatomy of* Ipomœa aquatica *Forsk., with Special Reference to the Development of Aerenchyma as a Result of injury.* G. C. ALLEN: *Charophyte Notes from Bareilly.* K. R. RAMANATHAN: *On the Cytological Evidence for an Alternation of Generations in* Enteromorpha. P. PARIJA AND P. MALLIK: *The Mechanism of the Bursting of the Fruits of* Impatiens Balsamina *Linn.* P. PARIJA AND P. MALLIK: *The Formation of Cuticle in Relation to External Conditions.* V. S. RAO: *Studies on Capparidaceæ. I.—The Embryo-Sac of* Mærua arenaria *Forsk.* A. C. JOSHI: *Anatomy of the Flowers of* Stellera chamæjasme *Linn.*

Meteorological Office Colloquium, Poona:

At a meeting held on the 17th December 1935, Mr. T. P. Bhaskara Sastry, M.A., F.R.A.S., Director of the Nizamiah Observatory, Hyderabad, gave an account of the work done at Hyderabad in connection with the preparation of the International Astrographic Catalogue. The work includes the determination of the relative positions of stars and their photometric magnitudes; a re-determination of the positions of stars in certain zones is in progress for the detection of stars with measurable proper motions. He also explained the photographic measurements on the positions of the small planet Eros during its last close approach to the Sun in 1931, made at Hyderabad as part of an International programme for an accurate re-determination of the parallax and distance of the Sun.

University and Educational Intelligence.

Annamalai University:

Lectures.

Dr. S. Chowla, Ph.D. (Cantab), Reader in Mathematics, Andhra University, delivered a course of three special lectures on "The Additive Theory of Numbers".

The following members of the Teaching Staff gave talks to the students on the subjects noted against each:

Dr. S. Ramachandra Rao—"Recent Nobel Prize Winners."

Mr. M. K. Muniswami—"The New Deal."

Buildings.

Tenders have been invited for the construction of 12 lecturers' quarters sanctioned by the Syndicate. Designs, plans and estimates for the following buildings are under consideration:

1. Music College.
2. Men's Club.
3. Union Hall.

Agra University:

Annual Report for 1934-35.—The year under report marks a distinct period in the progress of the University and will remain memorable in its annals for the completion of the University buildings, which were declared open by H. E. the Chancellor on 17th November 1934. The University office was removed to the new buildings in January 1935. Arrangements for Intercollegiate lectures continued during the year and were found to be very useful. Government have discontinued foreign scholarships, which used to be granted to the three universities in the Province by turns in past years. The number of examinees in all the degree examinations has been increasing steadily and this fact alone, among others equally strong, is sufficient to justify the existence of this University. It demonstrates clearly that the University meets a real demand and has been a potent cause of the development of higher education within its jurisdiction. The University is conferring degrees on 1,302 students this year.

The strength of the U. T. C. platoons attached to the University has remained the same as last year. In spite of their repeated requests, the Military authorities have not seen their way to increase the number of platoons and some of their colleges have to go without this useful training. It is hoped, however, that in the near future this long-standing grievance will be removed.

The quality of instruction and standard of teaching imparted in the colleges affiliated to the University have been of a high order, while the standard of examinations has been maintained at its usual high level. All the colleges have done well. By frequent inspections of the affiliated colleges under the guidance of a strong Board of Inspection, the colleges have been required to keep up to the desired standard. The Maharaja's College, Jaipur, has, through the efforts of the University, secured a magnificent building. A new degree college has been started at Bikaner, while they have received application for affiliation of a new college at Alwar.

All the University bodies have been alert and have discharged their duties efficiently. Certain proposals for improving the teaching of Law in the affiliated colleges are under consideration of the Faculty of Law and it is expected that the proposals if adopted will lead to turning out more efficient graduates in Law. Where all have done their part loyally and efficiently, it would be invidious to name some. But the services of the Registrar and the Assistant Registrar deserve special mention, who have worked with zeal and devotion in the discharge of their duties.

Benares Hindu University:

1. *Meeting of the Senate.*—The adjourned meeting of the Senate was held on December 7, 1935. Pandit Madan Mohan Malaviya, Vice-Chancellor, was elected to represent the University on the Court of the Indian Institute of Science, Bangalore. Among matters of academic importance considered by the Senate was the proposal to institute a one-year Diploma Course in Pharmaceuticals. The necessary Regulations were adopted and it was decided to forward them to the Visitor for sanction.

2 *Meeting of the Court.*—The Annual Meeting of the Court was held on December 20, 1935. The following officers were elected:—

Chancellor—Major-General His Highness Maharajadhiraja Raj-Rajeshwar Narendra Shiromany Maharaja Shri Sir Ganga Singh Bahadur, G.C.S.I., G.C.I.E., G.C.V.O., G.B.E., K.C.B., LL.D., A.-D.-C., Maharaja of Bikaner.

Pro-Chancellors.—(1) Major His Highness Raj-Rajeshwar Maharajadhiraja Sir Umed Singh Bahadur, G.C.I.E., K.C.S.I., K.C.V.O., Maharaja of Jodhpur. (2) His Highness Maharaja Sir Aditya Narain Singh, K.C.S.I., Maharaja of Benares.

Vice-Chancellor.—Pandit Madan Mohan Malaviya, B.A., LL.B.

Pro-Vice-Chancellor.—Prof. A. B. Dhruva, M.A., LL.B., I.E.S. (Retired).

Treasurer.—Rai Govind Chand, M.A., M.L.C.

3. *Convocation.*—The next convocation of the University will be held on February 23, 1936. His Highness the Chancellor will preside. Dr. Sir S. Radhakrishnan has been invited to deliver the Convocation Address.

H. H. the Maharaja of Jodhpur, Pro-Chancellor of the University, has consented to perform the opening ceremony of the Institute of Agricultural Research on February 21, 1936.

Dacca University:

Annual Report for 1934-35.—The total number of students on 31st March, 1935, was 960 as against 961 on the corresponding date in the previous session. The Departments of History and Chemistry organised tours of educational interest for their advanced students. The academic societies in connection with the several Departments of study held several meetings in which interesting papers were read and discussed.

The most important change in the staff of the University during the session is the retirement of Prof. G. H. Langley from the Vice-Chancellorship and the appointment of Mr. A. F. Rahman in his place. Mr. N. N. Ghosh, Professor of Law,

retired from service of the University on attaining the age of 55 years, and Mr. J. N. Das Gupta has been appointed Professor in his place. Out of the grant made by the Imperial Council of Agricultural Research to this University, it has been possible to make another appointment and Dr. A. C. Bose has been appointed Research Assistant in Agricultural Chemistry. This is an expanding Department of this University and in this direction the University can make valuable contributions.

Some interesting donations have been received. Shamsunnesa Khanum Saheba, wife of Khan Bahadur Naziruddin Ahmad, Registrar of the University, has donated Rs. 500 for the award of stipends to meritorious resident students of the Salimullah Muslim Hall; the stipends being called "Raoshan Akhtar stipends" in memory of her mother. Messrs. Shyam Chand Basak, Nibaran Chandra Guha Mustafi and Jogendra Nath Sen, executors of the Will of the late Babu Jagamohan Pal, have agreed to place at the disposal of the University a sum of 4 lakhs of Rupees for a Medical College at Dacca in the name of the late Jagamohan Pal. The University will very shortly submit schemes for the consideration of Government. Rai Saheb Devendra Kumar Roy of Dacca has placed at the disposal of the University three securities of Rs. 100 each for the award annually of a silver medal of the value of Rs. 15 to the student who stands highest in the Honours Examination in Sanskrit. The University has gratefully accepted these gifts and the thanks of the University are due to the generous benefactors.

University of Lucknow:

The degree of D.Sc. has been conferred upon Mr. S. K. Pande, Demonstrator in Botany for a thesis entitled "Studies in Indian Liverworts".

The following students have been awarded Research Fellowships in the University:

Physics: Mr. U. K. Bose; *Chemistry:* Mr. A. B. Sen; *Botany:* Mr. K. Jacob, Mr. H. S. Rao, and Dr. S. C. Varma.

The Ruchi Ram Sahni research prize in Botany has been awarded to Mr. H. S. Rao, M.Sc.

The Banerjee Prize has been awarded to Dr. S. K. Pande, Demonstrator in Botany.

Mr. R. S. Mathur, M.Sc., has been appointed a Research Assistant under Dr. K. C. Mehta (Agra) in connection with the scheme for research on Cereal Rusts.

University of Madras:

Two lectures on "THE FERMAT POINT" were delivered by Mr. V. Ramaswami Ayyar, M.A., in October 1935, under the auspices of the University of Madras. The lecturer defined the generalised Fermat point of a set of points $A_1A_2\ldots$. for multiples $\lambda_1\lambda_2\ldots$. as a point P for which the sum $\Sigma\lambda_i PA_i$ was a minimum. A few elementary theorems shew that the Fermat point of ABC for multiples (0,1,1) is any point of the side BC; for multiples (0,−1,1) it is any point of BC produced; for multiples $(-a, b, c)$ it is any point of the arc BC of the circumcircle. From these elementary theorems, and a simple principle which he styled the *principle of composition*, the lecturer shewed that the Fermat point for any set of multiples λ, μ, ν can be fixed readily by dividing the possible sets of multiples into a few categories.

The side-lines of a triangle ABC and its circumcircle divide the plane of the triangle into 10 regions. The lecturer shewed that Fermat points for all sets of multiples were confined to 4 of these regions.

In the second lecture, Mr. V. Ramaswamy Ayyar dealt with the analytical solution for the general case and explained the restriction of the position of the Fermat point to certain regions by the failure of Lagrange's conditions for a minimum in the other regions.

University of Mysore:

Central College.—The Diamond Jubilee of the Central College was celebrated on the 6th, 7th and 8th December 1935. There was a Science Exhibition in connection with the celebrations, which was inaugurated by His Highness the Yuvaraja of Mysore.

Oriental Conference.—The Eighth All-India Oriental Conference was held under the auspices of the University, at Mysore on the 29th, 30th and 31st December 1935, and it was opened by His Highness the Yuvaraja of Mysore.

Extension Lectures.—The following Extension Lectures were delivered:—

(i) Mr. A. R. Wadia, B.A., Bar-at-Law, on "Contemporary Socialistic Theories" in English at Tumkur.

(ii) Mr. Devudu Narasimha Sastry, M.A., on
  (*a*) Kalidasana Sandesa:
  (*b*) Karnataka Samskruti;
  in Kannada at Bangalore.

(iii) Miss B. M. Tweddle on "Development of Rural Industries" in English at Bangalore and Mysore.

Deputations.—At the invitation of the Indian Statistical Institute, Calcutta, Mr. K. B. Madhava, Professor of Mathematical Economics and Statistics, Maharaja's College, Mysore, delivered a course of lectures on the "Theory of Graduation" at Calcutta.

Messrs. B. M. Srikantia, T. S. Venkannaiya and A. R. Krishna Sastry were deputed to attend the Karnataka Sahitya Parishat Conference held at Bombay during the Christmas week.

The following members of the University were deputed to attend the Annual Meeting of the Indian Academy of Sciences held at Bombay during December 1935:—

1. Rao Bahadur Mr. B. Venkatesachar.
2. Mr. C. R. Narayan Rao.
3. Dr. B. Sanjiva Rao.
4. Mr. K. S. K. Iyengar.
5. Mr. L. Rama Rao.
6. Mr. A. Venkata Rao Telang.
7. Mr. L. Sibaiya.
8. Mr. T. S. Subbaraya.
9. Mr. M. P. Venkatarama Iyer.
10. Dr. B. K. Narayana Rao.
11. Dr. A. Nagaraja Rao.
12. Mr. K. S. Gururaja Doss.

Educational Conference, 1935:

The Eleventh Session of the All-India Educational Conference was inaugurated on December 28, 1935, at Nagpur by the Right Hon'ble V. S. Srinivasa Sastry.

Mr. Shyama Prasad Mookerjee, Vice-Chancellor of the Calcutta University, in his Presidential

Address spoke upon the benefits as well as the evils of the present system of higher education. He said that Government should take immediate steps to introduce free and compulsory education throughout India Technical and industrial education should be based on a minimum of sound general education. "Unrestricted admission to the army and the navy, Government assistance to indigenous industries and a close association between the universities, the industrialists and the educational authorities," are all necessary for a satisfactory settlement of the problem of unemployment.

The following are some of the important resolutions passed at the Conference.—(1) Secondary School Education should be divided into well-defined stages complete in themselves and should have arrangements for diversified courses, which will equip the pupil, along with a cultural education, with the necessary qualification to meet the requirements of modern industry and commerce. (2) The Conference disapproves of the proposals of the Central Board of Education to have separate secondary school and special examinations for recruitment to the various subordinate services. (3) In order to get expert advice for diversified courses in secondary education, the Conference recommends that selected Indians closely connected with Educational work and possessing high educational qualifications be sent abroad for additional training, if necessary. (4) In view of the great urgency and importance of adult education in India and the necessity for co-ordinating the activities of the different Provinces and States in this direction, it is resolved that an All-India Adult Education League be formed under the auspices of the All-India Federation of Educational Associations with headquarters at Calcutta or any other convenient place.

The Conference, further, appealed to the Government for the immediate establishment of an Institute of Education and Psychological Research on an All-India basis. A committee was appointed to investigate the possibility of adopting a common language and script for the country. Another resolution was adopted regarding the celebration of Education Week throughout the country to give the public an idea of the work and the needs of educational institutions. Another important resolution of the Conference favoured the idea that handicrafts should form an integral part of all education—primary and secondary stages.

Post-Graduate Work in the Indian Universities.

THE Inter-University Board has published a pamphlet containing information regarding the Doctorate Theses in Science and Arts accepted by the Indian Universities from January 1930. The brochure is drawn up with the specific object of providing guidance to post-graduate research students, and it contains reference to investigations in Science and Arts pursued in the Universities. Dealing with the three oldest Universities, we find that during the years 1930-35, Calcutta conferred the Doctorate Degree on 48 candidates from whom the University received 120 theses, while Madras during the same period awarded similar degrees to 10 candidates submitting 10 theses, and Bombay offered to one. Some of the comparatively younger Universities like those of Dacca and the Punjab have conferred degrees on 12 and 13 candidates respectively. Nearly 7 Universities in India do not offer doctorate degrees. Candidates from these Universities will have to migrate to other centres if they wish to obtain doctorate degrees, and when they have to do so, the book gives them no information regarding the colleges where facilities for special types of research work exist. The Indian Universities have not adopted a uniform denomination in respect of the doctorate degrees, for example the Ph.D. degree of the Aligarh University is a science degree, while that in the Universities of Calcutta, Dacca, Madras, Lucknow, represents an Arts degree for which Allahabad and Benares have adopted D.Litt. Practically all the theses accepted by the Universities for the doctorate degree are published either in foreign and Indian scientific Journals or in the University magazines, and they will always be available for the 'Scientific World' and for reference by students in the libraries of the Universities which are equipped for post-graduate research work leading to the doctorate degree. However, all research scholars will appreciate the labours of the Inter-University Board in producing this pamphlet which is a sort of made-easy of reference work. We think that diligence in finding out reference to literature on problems under investigation is an index of the students' aptitude for research, and frequently a hunt for special information through heavy volumes results in the discovery of fresh problems and in stimulating new ideas. Does the pamphlet favour this?

In the pamphlet we could discover more than seventy titles of theses without any information as to their destiny. We are not referring to those which are specifically mentioned as not published. "The Scientific World" would wish for more detailed information regarding these important researches than is provided in the pamphlet.

Reviews.

Relativity. By F. W. Lanchester, LL.D., F.R.S. (Constable & Co., Ltd., London. 1935.) Price 12*s*.

This contribution to relativity from a man who learnt it from Minkowski and Runge deserves serious notice. Lanchester is famous for his power of physical insight which is so conspicuous in his fundamental researches in Aerodynamics. An equally characteristic trait of his work is the lack of mathematical developments. As Prandtl* once remarked, this absence of mathematics does not make his writings easy reading but on the contrary "Lanchester's treatment is difficult to follow, since it makes a very great demand on the reader's intuitive perceptions". These characteristics of the author's work are to be abundantly found in the book under review. It is described as "an elementary explanation of the space-time relations as established by Minkowski, and a discussion of gravitational theory based thereon" and is addressed "to the young student who has yet far to go in his mathematical training". The description can be taken to be true as far as Part I of the book is concerned. Here the underlying principles of the special theory of relativity have been made clear by geometrical methods, almost "*visibly*," as the author puts it, by the aid of diagrams. In fact, the treatment is so simple and beautiful that an enthusiastic reviewer of this book has somewhere remarked, if our memory is right, that the arguments could be grasped even by a sixth form student! Such a sixth form student would indeed be a marvel!

Part II, on the other hand, makes a little difficult reading not because of any mathematical formalism, not even because of the complexity of the physical concepts, but on account of the lack of fulness in the treatment of the several topics dealt with and the failure to take arguments to definite conclusions. Perhaps, the value of the work lies in this very weakness. The author has thrown out brilliant and original suggestions for others to pick up and knowing the history of Lanchester's previous work in Aerodynamics, it would be certainly extremely rash to dismiss the author's suggestions as idle speculation without bringing them to a finality by applying mathematical methods. Among the numerous suggestions throughout the book we might choose, as an illustration, the topic of rotation in space-time in Chapter X. The remark that the spin of the electron is to be associated with *a rotation about a time-axis* is highly suggestive and gains extra significance if taken in conjunction with Kramers' recent derivation of electron spin from purely classical relativistic considerations.

A very suggestive and original book on relativity. Finally no reviewer can be said to have done his job properly if he does not pick holes and so here it is: on p. 62, first sentence, it is wrongly stated that $\sqrt{-1}$ is an *irrational* quantity!

B. S. MADHAVA RAO.

*Prandtl, L., "Wilbur Wright Memorial Lecture," 1927, *Journal of the Royal Aeronautical Society*, August 1927, **31**, No. 200.

The Work of the Sanitary Engineer. By Arthur J. Martin, Major, R.A.M.C., T.F. (Retired), M.Inst.C.E., F.R.San.I. Demy 8 vo. (Macdonald and Evans, 1935). Pp. 488. 81 illustrations. Price 16*s*. net.

Any one who has had experience of writing a book on a technical subject, and is therefore aware of the toilsome effort required to marshall and verify references and condense the necessary information, cannot but admire the industry and ability which Mr. Martin has brought to the completion of his task. Mr. Martin's book is moreover no mere compilation from existing publications. It is continually brightened by short illustrations from his own exceptionally varied experience as a Consulting Engineer in many parts of the world, and the criticisms which he permits himself on matters on which opinions may differ are always helpful and based for the most part on first-hand knowledge.

The book is divided into six parts:— I. Sanitary Administration. II. Water Supply. III. Drainage and Sewerage. IV. Sewage Disposal. V. Collection and Disposal of Refuse. VI. Flood Prevention, Land Drainage and Coast Protection.

Part I on Sanitary Administration contains much carefully compiled information of value to the young engineer especially on such matters as the different bodies concerned with Local Government and Expenditure, Engineering Societies and

Professional Training and the administrative details concerned with Public Works.

Part II on Water Supply contains 12 chapters in which the whole subject is treated comprehensively and in a manner which constantly awakens the interest of the non-specialist reader. It is thus surprising to read that the contents of an ordinary bath may vary from 28 to 70 gallons. The excessive water consumption of American cities where in even middle class houses every bedroom has its own bathroom, may thus be partly accounted for. The increasing use of electrical refrigerators of various types is mentioned as another cause of growing water consumption. The debatable subject of metering is discussed and a useful system is quoted for combating waste by sectional metering of districts during the night.

Parts III and IV on Drainage and Sewerage and on Sewage Disposal respectively are to some extent interconnected. Thus the difficult subject of storm-water demands attention both in the design of sewers and of disposal works. Mr. Martin's views on the methods of dealing with storm-water after reaching the disposal works are practical and sound, inasmuch as he recognises the necessity for dealing thoroughly with the "first flush" of a storm whatever the actual *rate* of flow during the period of the flush may be since all of it is usually highly polluted. He does not, so far as the reviewer has been able to discover, face the difficulty of storm overflows on the sewer itself, prior to the entry of the disposal works. Such storm overflows are a serious source of pollution in many cases and while their necessity may be admitted as a safeguard against gorging of the sewer and possible disaster, it would seem not beyond the ability of the engineer to devise some method of arresting the heavier polluting matters before they are actually discharged into the river or stream there to form mudbanks.

Thoroughly to discuss the fourteen chapters of Part IV on Sewage Disposal would itself require a small book. Suffice it to say here that both the historical development of the subject and the details of recent modes of treatment are handled with fairness and critical judgment. One or two small omissions and errors of statement or printing may be mentioned. On p. 312 it is stated that an Imhoff tank was installed at Whitstable. Actually it is believed the first Imhoff tank in England was installed at the Withington works of the Manchester Corporation and its working was fully reported upon in the Annual Reports of the Rivers Committee. So far as the reviewer remembers no mention has been made in those Reports of the treatment of the effluent from the contact beds at Withington with activated sludge, as stated on p. 349 of Mr. Martin's book. On p. 335 "Stourport" the headquarters of Messrs. Jones & Attwood, the engineering pioneers of the Activated Sludge process, should read "Stourbridge," and in the Bibliography on p. 384 the substitution of "Nitrogen Compounds" for "Nitrogen Conservation" seriously alters the significance of the title of the book referred to.

Such slips however are singularly few in a book of nearly 500 closely printed pages.

The book being written by an experienced sanitary engineer for members of his own profession, it would not be fair to criticise it for its limitations in the domain of biochemistry, especially as its author has always urged the importance of continued scientific research if the treatment of sewage was to be rescued from empiricism. It must be admitted that a greater proportion of the ability of the engineering as compared with the chemical profession has been devoted to the problems of sanitation. The reasons for this are various. The work of the engineer and its importance are more readily recognised by the lay public who have to pay the bill. The engineer of necessity has to supervise construction works of magnitude and so is responsible for control of labour and expenditure. Nevertheless all such expenditure and ability may be largely wasted if the underlying biochemistry is imperfectly understood. Actually the number of scientific fundamental researches, *e.g.*, on the Activated Sludge process, which have appeared since the original papers from the Manchester laboratories, are very few in comparison with the hundreds of papers concerned with mainly engineering features. And yet as the late John Hawworth stated, as quoted on p. 347, the Activated Sludge process still offers a boundless field for research and experiment. The work of the Water Pollution Research Board referred to on p. 270, is doing much to remedy this state of affairs, and Mr. Martin is to be congratulated on the fruition

of the appeal he made in a paper read so long ago as 1913 before the Institute of Sanitary Engineers.

His present book should help much towards even more fruitful and intelligent co-operation than in the past between the engineering and chemical professions.

G. J. F.

Electrochemistry, Vol. 1, Principles. By H. J. Creighton. (John Wiley & Sons, Inc. New York; Chapman and Hall Ltd., London 1935. Third Edition. Pp. 502. Price 20*sh*.

Students of Electrochemistry will welcome the third edition of the Principles of Electrochemistry by Creighton. The book is deservedly popular and serves as an excellent introduction to the study of this rapidly growing subject. The exposition of the older classical ideas and methods has been very lucid, and the numerous references to original papers given throughout the book will help the serious student to obtain easily more detailed information on the topics prescribed.

In the second edition in 1927 the author considered carefully "an alteration of treatment throughout the book to conform to the activity concept" but decided that it was advisable to postpone such a change to a future time when more experimental data had been obtained and this and allied conceptions had been stabilised.

In the third edition just published, the author has taken the opportunity of bringing the treatment of many topics into harmony with recent advances. He has succeeded well in his task. We wish, however, that more space had been devoted to recent work on some chapters, *e.g.*, ampholytes, heterogeneous equilibria, electromotive force of oxidation reduction cells. A chapter on photo-voltaic cells would have been also welcome.

There are to be found a few statements in the book, which we hesitate to accept as a correct account of our present knowledge of the subject. To take an example, on page 57, discussing Debye's equation relating dielectric constant with temperature, it is stated that "The results of recent measurements, however, do not entirely verify this equation," and in support, reference is made to the work of Jezewski, *J. Phys. radium*, 1922, **3**, 293.

We heartily recommend this book to all students and teachers of Electrochemistry.

J. C. G.

Electrical Measurements in Principle and Practice. By H. Cobden Turner and E. H. W. Banner. (Chapman & Hall, Ltd., London,) 1935. Pp. 354. Price 15*s*.

This book is chiefly remarkable for the wide range of electrical measurements dealt with, as, in addition to the measurements formerly included in a book of this nature the measurement of electrical quantities at audio and radio frequencies is treated as well as quite a large collection of miscellaneous measurements of considerable general interest. These include temperature, speed, boiler house quantities, X-ray current and voltage, noise and soap quality to mention but a few of them, so that the book becomes a very useful reference and an interesting collection of electrical devices.

After an introductory Part I on units and standards, electrical instruments are classified according to the electrical phenomenon on which their action depends and the authors have then a good deal to say about miscellaneous devices and measurements such as thermionic voltmeters, testing sets, oscillographs and potentiometers A.C. and D.C. This is followed by Part III on the measurement of current voltage, power and energy, chiefly but not entirely, at power frequencies, while Part IV deals with the measurement of resistance, capacitance, etc., by D.C. as well as by A.C. of audio and radio-frequencies. Part V deals with indirect measurements and includes many of the interesting devices mentioned above but many more are given under the previous headings also.

From a heavy engineering point of view, however, it might be contended that the book deals only superficially with important aspects such as wattmeter errors and measurement of small differences of phase, while the very important bridge method of measuring power has only a mere mention. Also some additional detail might be expected regarding, *e.g.*, the construction of a valve oscillator to be used as an A.C. source since a very simple form of this appliance can be made and used for bridge measurements. However, in spite of these limitations and considering the scope and price, the book is well worth while.

KENNETH ASTON.

Foundations of Chemistry.—By K. Suryanarayana, Professor of Chemistry, Pachaiyappa's College, Madras. Pp. 703. Price. Rs. 5. (Published by the Author, 326, Pycroft's Road, Madras.)

This is a text-book intended to supply the exact requirements of candidates preparing for the Intermediate Examination of Indian Universities.

Excepting those that deal with purely theoretical topics, all the other chapters contain detailed instructions for laboratory work pertaining to the subject-matter of each chapter. In trying to make the instructions comprehensive, the author has sometimes indulged in superfluous verbiage.

The descriptive portions of the book are quite satisfactory. There is an abundance of diagrams which are very well drawn. A good number of questions is given throughout the book.

The printing and get-up are very good. The book contains most of the material required for the Intermediate syllabus of the Mysore University.

M. SESHAIYENGAR.

Exercises in General Chemistry and Qualitative Analysis. By H. G. Deming and S. B. Arenson. (John Wiley & Sons, Inc. U.S.A.; Chapman and Hall Ltd., London.) Fourth Edition. 1935. Rewritten and Revised. Pp. xv+326. Price 9*s*.

The book under review aims at an elementary laboratory course in General Chemistry for the College Classes as a companion volume to Deming's "General Chemistry". The object of an elementary laboratory course in Chemistry as stated by the authors in their preface is not merely to impart chemical information but to develop the chemical outlook. The student should be made to be familiar with a few representative types of matter and should grasp the general principles of Chemistry; and more than all he should receive a sound training in the experimental technique employed in investigations of a fundamental nature. The first 226 pages of the book are devoted to about 75 practical exercises most of which can be performed by the average student in a 2-hour period. These include the well-known inorganic preparations, verifications of the quantitative laws in Chemistry, fundamental concepts like Oxidation and Reduction, Physico-chemical measurements, such as, verification of Faraday's laws of electrolysis, conductivity of solutions, freezing point measurements, P_H values and heat of neutralisation. A few exercises of Engineering importance, such as, analysis of water and calorific value of fuels are also added. New experiments on Photography and Sensitivity of qualitative tests have been included in the present edition. The latter part of the book deals with systematic qualitative analysis of inorganic mixtures. The special feature of the book is the list of questions at the end of each exercise which will require the student to make careful observations in connection with each experiment as also to understand the theory underlying the same. The book is obviously written with special reference to courses in Practical Chemistry as adopted by American Universities. It would be worth while considering if elementary practical courses in Chemistry in our Universities could not be modelled on lines similar to those adopted in this book.

M. P. V.

The Chemical Control of Conception. By John R. Baker, M.A., D.Phil. (Chapman & Hall, 1935.) Pp. x+173. Price 15*s*.

In reviewing "The Chemical Control of Conception" by Dr. J. R. Baker with a chapter by H. M. Carleton, one is struck with admiration at the scientifically cautious attitude of the author. The book is intended for the expert who amidst the glut of commercially well-advertised contraceptives—both occlusive and spermicidal—has to choose one which would give a cent. per cent. safety and satisfaction. The work has been undertaken at the instance of the English Birth Control Investigation Committee; detailed descriptions are given of the technics which he has standardised for the purpose of accurately grading the spermicidal powers of pure substances and of proprietary preparations. The mode of action of substances upon sperms is discussed and very cautious conclusions are drawn therefrom. Historically it is interesting to note that Kölliker in 1854 made the first investigation of the action of substances upon sperms. As defined by the author "the ideal spermicide for practical use would be a very soluble, stable, non-volatile, inodourous, non-irritant, inexpensive solid substance moderately or strongly spermicidal in the presence of proteins in both alkaline and in acid media within physiological limits". Such an ideal spermicide is

yet to be found. The book contains Appendices of the actions of various chemicals in various dilutions on isolated sperms at various time intervals. The guinea-pig sperm or as it is called "cavy sperm" is the one that has been used throughout. One realises the difficulty on a perusal of the book, in using or in advising to use, any chemical spermicide, wholeheartedly, as hundred per cent. efficient. The chapter on the Pathology of the contraceptives by Dr. Carleton errs, perhaps, on the side of ultra-caution. It is said "in many cases the use of contraceptive substances and proprietary compounds which are permanently adopted by Birth Control Clinics as routine methods, it is not known whether a product is harmful or not by adequate experimental tests"; this is a statement which is absolutely true. Dr. Carleton comes to the conclusion that "a really potent chemical contraceptive which is also devoid of any pathological effects has yet to be found". On the whole, the book is a remarkable and outstanding contribution on the subject of Birth Control. It is well printed; the price is perhaps too high (15*sh.*). I would strongly recommend the book to find a place in the library of every medical man, as also every social worker interested in population problems.

N.

Descriptive Mathematics. By John Maclean, M.A., B.Sc. (Macmillan and Co., Ltd., London, 1935.) Pp. xvi+143. Price Rs. 2–8–0.

This is a companion volume to the author's *Graphs and Statistics* (1926). To quote from the preface, "In contrast with *Graphs and Statistics* (1926) where the stress was laid so much on the applications that mathematicians found but little interest in it, the emphasis here is often intensely mathematical". Apart from a few pages dealing with Finite Differences, the "intense" mathematics is however of the Intermediate standard. The author's intention has not been to produce any text-book to be used by the general class of students. He claims to have introduced new features and methods which would benefit the more enterprising teachers and students. Considering, however, the mathematical knowledge of the students who would use the book, and looking through the contents of the main chapters, it is hard to see how this book would stimulate more thinking on the part of an intelligent student than any of the modern well-planned text-books. Few teachers would agree that the book is successful in presenting "an outlook on mathematics which makes it, not the embodiment of definiteness and authority but a home of the free creative spirit".

There are books on mathematics written mainly or solely for the use of scientists of other branches, such as chemistry. Similarly, should there be statisticians whose background of mathematics is negligible, they would find the present book a very useful object of perusal, if associated with some text-book such as Freeman's text-book in the Actuarial Mathematics Series.

Amongst Macmillan & Co.'s mathematical publications, I have not seen a book using closer print and worse paper than what are used here. I should not be surprised if many of the Intermediate students of Indian Universities would treat this book as one more of their text-books on English Prose—the language used in a book on mathematics ought to be far, far simpler in style.

C. N. S.

Plant Life, A Text-book of Botany. By D. B. Swingle. (Chapman & Hall, Ltd. London, 1935.) Pp. 441; Figs. 290. Price $3.

Dr. D. B. Swingle of the Montana State College, Bozeman, has recently written a new text-book of Botany, which has many excellent features. The treatment centres around the life processes of plants—their methods of obtaining food, its subsequent use for growth and reproduction, and the means they adopt to protect themselves from the dangers that beset them. The style of writing is so simple that even the dullest student should have the minimum of difficulty in working his way through the first 15 chapters, dealing with the fundamental aspects of plant physiology and structure. Chapters XVI to XXIV deal with typical representatives of the plant kingdom. The bulk of the matter here is organised in the usual orthodox manner, but there is a freshness of treatment that makes it agreeable. A good feature not always seen in text-books, is that after describing each group of plants the author gives a paragraph on its economic value and another on its relationships to other groups. Chapters XXV and XXVI deal with the main

facts of evolution and Mendelism including an account of fossil plants. The last three chapters are devoted to ecological considerations and in the end there is a useful glossary of technical terms. At the close of each chapter there is a list of questions for review, which will serve to stimulate thought on the part of the student and revert his attention to many important facts in the text, which he might have overlooked in the first reading.

The illustrations are in general very satisfactory. Good care has been exercised in the selection of those that have been borrowed from other books. Of these Fig. 163 on *Oedogonium* has evidently been taken from Chamberlain's *Elements of Plant Science*, although the credit line has been omitted due to oversight. Fig. 95 (illustrating secondary growth in dicotyledonous roots), stated to have been borrowed from the *3rd Edition* of the well-known text of Holman and Robbins, is really taken from the older editions. The latter authors have entirely redrawn this group of figures in their latest edition, for it is unthinkable that such an old root as that shown at "D" should have remained without cork formation in the pericycle. In the figures on mitosis a continuous spireme thread has been made in the prophase, although most cytologists are now agreed that the chromosomes remain separate and do not join end to end in this fashion.

On p. 197 it is mentioned that there are at least 200,000 species of seed-bearing plants, while according to the estimates of most taxonomists this number is well under 150,000. In dealing with the life-history of angiosperms, more particularly the development of the female gametophyte, it is mentioned that *Lilium* follows an unusual course and therefore it should be substituted by a general type. Rather ironically the figures accompanying the description are still those of *Lilium* which is clearly a mistake.

On the whole it can be said that the book has many excellent features, which should make it very useful to elementary students of Botany. It is hoped that the defects pointed out above will be remedied in the next edition.

P. MAHESHWARI.

Ciliate Protozoa.

(1) WIMPERTIERE ODER CILIATA (INFUSORIA): In Dahl's *Tierwelt Deutschlands*, Teil 18, 21, 25, 30. 1. Allgemeiner Teil und Prostomata, pp. 1-180, 607 Figs. (1930); 2. Holotricha, pp. 181-398, 831 Figs. (1931); 3. Spirotricha, pp. 399-650, 916 Figs. (1932); 4. Peritricha und Chonotricha, pp. 651-886, 1053 Figs. (1935). By A. Kahl. Gustav Fischer, Jena. Price Rmk. 64.

(2) TINTINNIDAE. In Grimpe's Tierwelt der Nord-und Ostsee, Teil C 1-2, pp. 1-28 (1932-33).—By E. Jörgensen & A. Kahl. Akad. Verlags., Leipzig.

(3) CILIATA LIBERA ET ECTOCOMMENSALIA. *Ibid*, II. C 3, pp. 29-146, 888 Figs. (1933). By A. Kahl.

(4) CILIATA ENTOCOMMENSALIA ET PARASITICA. *Ibid*., II. C 4, pp. 147-183, 138 Figs. (1934). By A. Kahl.

(5) SUCTORIA. *Ibid*., II. C 5, pp. 184-226, 228 Figs. (1934). By A. Kahl.

With the publication of the fourth part, just issued, has been completed a monograph on the free-living Ciliate Protozoa of the world, of great worth and practical utility to the workers on the group. Ever since the days of the early microscopists, the ciliates living in ponds and puddles, presenting such a diversity of form and structure, have been favourite objects of study. The number of new genera and species discovered in all parts of the world has gone on increasing, and the serious student of the group is bound to experience considerable difficulty in consulting the vast and scattered literature dealing with them. Saville Kent's Manual of Infusoria, published more than fifty years ago, gave a description of all the forms known till then. Schewiakoff's great monograph on Infusoria aspirotricha (1896) being in Russian, was of restricted usefulness, though the classification introduced by him has been generally followed. Stokes in America (1888), Roux (1901) and Penard (1922) at Geneva have published valuable monographs on the freshwater ciliates, but they only dealt with the forms that came under their personal observation. The works of Blochmann (1895), Eyeferth-Schoenichen (5th edition, 1927), and Lepsi (1926) have all stood the worker in good stead, by making available synoptical keys and short descriptions of a large number of genera and species, but they could not be relied upon for adequate description of all known forms. During the last decade, Dr. Kahl of Hamburg has been unquestionably the most energetic worker on the group, and had published a good deal of important work, before undertaking the monographs now under review. *Die Tierwelt Deutschlands* is supposed to deal with the fauna of Germany and the

neighbouring seas, but the free-living ciliates are cosmopolitan in their distribution, and the learned author has wisely given a description of practically all known forms of the world. The scientific periodicals of the world (including some very obscure ones) have been carefully scanned for information, and the genera and species brought under a well-planned system of classification. There are several new families and quite a big number of genera and species which the author himself has established. In all 372 genera and close upon 2,000 species are dealt with. The descriptions are accompanied by more than 2,400 small-sized text-figures grouped together in 155 plates. There are identification tables for families as well as genera and species. The work is very thorough and up-to-date, and the students of the group will bless the author for this admirable monograph.

In the monographs concurrently published in *Die Tierwelt der Nord-und Ostsee* there are synoptical tables of all families and genera, though of course only forms living in sea-water or parasitic in marine animals are enumerated and sketched. In the part dealing with entocommensals and parasitic marine forms, two new sub-orders, Thigmotricha and Apostomea, established by Chatton and Lwoff in 1922 and 1928 respectively, have been included, and the fragmentary information relating to them, hitherto found scattered in a number of papers, brought together.

With this series of monographs the researcher will be guided safely, and no one who aspires to identify known forms or to describe new ones, can afford not to consult them constantly.

B. L. BHATIA.

Electrotechnics, No. 8. (Electrical Engineering Society, Indian Institute of Science, Bangalore.) Pp. xvi+198. April 1935. Price Rs. 2.

The editorial board should be specially congratulated on their splendid success in bringing out this issue of *Electrotechnics*. This number is the biggest of those published so far and contains 29 technical articles, the choice of the subject-matter being so wide that one or the other of them should be of interest to any one in the engineering profession. The topics cover manufacturing processes, electro-chemical industries, design and research notes, electrical communication, electric traction and general engineering.

The editor's scheme for "Nationwide Broadcasting in India" has attracted a great deal of attention. We may disagree with the writer on some such grounds as extravagance but it is obvious that his plan is the result of a careful study of the systems in use in other countries and it must be of great interest to the general scientific reader and in particular to those who will be responsible for the setting up of a broadcasting system in this country.

While this article must necessarily be to a large extent statistical it should be observed that statistics generally make rather dismal reading and there is a tendency in several articles in the number to run to statistics.

Also it might be wished that the publication as a whole could have been less verbose. Engineers should aim at a concise statement of fact rather than at a literary composition.

Considering the scarcity of high class electrical journals published in India and coming, as it does, at the stage of technical development that India is passing through at present, the *Electrotechnics* deserves co-operation from everybody interested in the electrical development of India, both in the industrial and academic fields.

The Calculus of Plenty. By Sir Josiah Stamp, G.C.B., G.B.E., LL.D., D.Sc., F.B.A. being the Norman Lockyer Lecture for 1935, delivered before the British Science Guild on November 13th, 1935.

In this lecture Sir Josiah Stamp seeks to bring into measurable order the various concepts of Plenty comprised under the widespread phrase "Poverty in the midst of Plenty".

He states that all the cases are covered by a main three-fold classification with various sub-heads. First, the plenty of physical or scientific potentiality; second, the plenty of unused or unmarketed production; third, the plenty of unused capacity.

Quoting Lord Kelvin's dictum that "we never know much about anything until we have contrived to measure it," he begs the term *"Calculus of Plenty"* as an indication of the scientific discipline which is necessary for the mind, when it proceeds from its composite concept of plenty, to deductive inferences for human action and policy

The problem, he contends, is a summation of successive equal units or magnitudes with receding (*a*) *time potentials* (where, for example, an invention can only be brought into full use gradually, (*b*) *cost potentials* (where fuller utilisation of unused capacity involves greater proportionate expense for each unit), and (*c*) *demand potentials* (where increased supplies can only be sold at lower prices).

He then proceeds to analyse the figures submitted by Technocracy and writers in sympathy with the ideas which that movement represents. He points out that the gross theoretical or *technical* capacity based on engineering ideas, has to be brought down to the more important *economic* capacity by a number of stages. These may be shortly indicated as follows: (1) A 100 per cent. use is in practice unattainable, a necessary operating reserve must be maintained. This he terms the *operating margin*. (2) Perfect integration of all industries supplying other industries, and not the final consumers demand, is seldom attained and so results "*unco-ordinated surplus capacity*". (3) Allied to the foregoing, but *not* due to lack of co-ordination is "*seasonal surplus capacity*". (4) Two industries may have surplus capacity technically equal yet vastly different in "practical demand potentiality." People may desire radios more and more and pianos less and less. (5) When demand has strengthened to a point that entrepreneurs are actively providing new plant to meet it, we have *capacity technically displaced on rising demand*. (6) Capacity may also be displaced on a *stationary* demand by reason of new inventions, which may be termed *invention displacement*. We have also to consider (7) *economically misplaced capacity*, (8) *cyclical surpluses*, and (9) *wasteful exploitation, e.g.*, rapid using up of timber without afforestation.

In further interesting paragraphs Sir Josiah discusses actual attempts at measurement and different intensities of demand. In the section on *Gluts, overproduction, restriction and destruction*, he deals with what has awakened the real interest of the general public, such matters as the ploughing-in of cotton and the burning of coffee in Brazil.

Finally he attempts *The Measurement of the Subjective, viz.*, "the force of that human desire which alone makes objects wealth".

Altogether the lecture is one which any earnest student of present-day economics may usefully read. Nevertheless and although in fairness to the lecturer it should be stated that while he disclaims any desire to "debunk" the phrase "Poverty in the midst of Plenty", it is difficult not to be reminded of Henry Ford's distrust of "experts". The moment one gets into the "expert state of mind" Henry Ford* says "a great number of things become impossible". The need for exactitude of thought and measurement may be freely granted, but only as a means to an end. Too often the inertia of the human mind is satisfied with such preliminary effort, as a doctor might be satisfied if he can correctly name a disease. The elaborate statistical studies of Seebohm Rowntree and others, though they may have accurately measured the "poverty line" in certain cities, do not seem greatly to have mitigated poverty, the real "trouble of the poor" to quote Bernard Shaw. "The expert state of mind" is too often concerned with things as they are or have been in its experience. Thus it might be conceived that in the days of hansom cabs and "growlers" an expert committee called to report on the possible improvements of street passenger transport in London, would collect all available statistics with reference to the best design of cab, the proper care and feeding of horses, and the necessary education of cabmen. The real remedy is the *taxi*.

In Josiah Stamp's lecture frequent reference is made to prices and profits, and the maintenance of the present financial system would seem to be tacitly assumed. More and more, however, it is coming to be realised by quite responsible thinkers that the present economic system is nothing less than a desperate form of warfare, that the profit motive is incompatible with the more abundant life for the mass of the people. Until that motive is replaced by the spirit of service it may be doubted whether compilation of statistics, however necessary and useful as an aid to reconstruction, will greatly help us to the realisation of true "Plenty" in all its implications.

G. J. F.

**My Life and Work*, p. 86.

Report of the Punjab Irrigation Research Institute for the year ending April 1935. (Printed by the Superintendent, Government Printing Press, Punjab.) 1935.

The Irrigation Research Institute of the Punjab which was established with the object of investigating the rise of the water-table and the consequent serious water-logging brought about by the extension of canal irrigation, has largely expanded its scope of activities and now embraces six major sections dealing with various aspects of the special irrigation problems that the network of canals has brought in its train. The Chemical, Physical, Mathematical, Hydraulic, Statistical, and Land Reclamation sections comprise the Institute at present and fundamental problems as well as those of practical application are being studied, and the Institute is already serving the needs of new irrigation works with valuable data. The most important from the point of view of the agriculture of the tract is certainly the work relating to the deterioration of soils due to alkalinity and the methods of reclaiming them, the initial objects in fact of the Institute. Drainage and washing out of the salts together with applications of gypsum constitute the methods of reclamation of even these highly alkaline soils whose pH values range between 8·5 and 10·0 and which in the first year of reclamation are too stiff for the drains to run. It is interesting to note that in the course of about three seasons the land is improved well enough to grow not only paddy but even sugarcane with moderate yields. The net cost per acre of the reclamation after deducting the income from the crops raised is put down as Rs. 220, and the period of time involved as four seasons.

The Chemical section has also correlated the depth of the underlying kankar layers to the facility of reclamation, the nearer such layer is to the surface the more easy is the reclamation. An easy method of judging the safety of irrigation waters for irrigation is also indicated by noting the ratio of the total Na to the total Ca in the water.

The study of silts has formed an important part of the work in the other sections as likewise the subject of the uplift pressures on dams. The Physical section reports an important method of investigation of such pressures by means of electric appliances which has yielded satisfactory results. The large resort to the use of models in the physical and hydraulic investigations is also a noteworthy feature of the year's work, notwithstanding the difficulty of approximating closely enough to natural conditions which such a method usually presents. A welcome feature of the work in all sections is the association of the Statistical section which is a guarantee of the reliability of the results; this is a fortunate circumstance as most of the field and other experiments of the past in this country have not had this advantage and have suffered in value in consequence. The Institute is probably unique in the comprehensive and many-sided study it has undertaken of problems which concern the welfare of the whole country and both the Director and his colleagues have to be congratulated on the results of the year's work.

Erratum.

Current Science, Vol. IV, No. 6, December 1935, Page 395, right-hand Column, Line 19 :—

Read $\frac{1}{M}$ *for* M.

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